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No. 17

NEW YORK, APRIL 27, 1916

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VOL. XXXIV NEW YORK—THURSDAY, APRIL 27, 1916—CHICAGO No. 17

The AUTOMOBILE

The Case for the Four

Resume of Situation and Ideas of Two Engineers Who Present Four-Cylinder Side of the Matter—Possibilities of Well-Defined Field for Each Type and Displacement

By J. Edward Schipper

FOUR-CYLINDER manufacturers as a body have been placed in the position of a defendant in the courtroom. The plaintiff, in the form of manufacturers of six-, eight- and twelve-cylinder engines, has stated his case and presented his arguments. The defendant must have an opportunity to answer before the case goes to the jury, which is in this case of considerably more than twelve men since it consists of the entire automobile-buying public. The judge who charges the jury and passes upon the points of law in this trial of fours vs. multis is the body of engineers which passes upon the technicalities involved.

In a way it is almost a foregone conclusion that the jury will disagree in this case. That this is true can be seen from the fact that the jurors themselves are largely guilty of prejudice, favoritism or some other quality which would render them ineligible to serve. This partiality on the part of the jury is evidenced by the fact that its various members are riding about in cars in which the cylinder numbers vary between four and three times that number.

In opening a legal case in order to secure the greatest possible dispatch it is customary for both sides to concede points upon which they are agreed. This avoids the necessity for arguing upon facts on which there is no difference of opinion. There are several of these facts that are agreed upon by both the fours and the multis and before the defendants' case is reviewed these facts should be noted.

There is no such thing as the ideal car. On the contrary, there is a different ideal for every set of requirements. It is this condition that stimulates automobile manufacture and renders it possible that there be such a large variety of makes and models. It is also this possibility which renders it permissible or even possible to make cars having a varying number of cylinders. The point, however, to be made by the defendants of the four-cylinder motor, is whether or not fours are suitable for every class of work or whether they have a well-defined field which embraces a greater part of the possible requirements of the motoring public with the other part open to builders of sixes, eights and twelves.

This condition of varying requirements is one of the conceded points. The others are largely along the lines of what individual owners demand in their cars. Taking the average owner, he is found to be the possessor of a five-passenger touring car of which he demands the following qualifications:

1—*Flexibility*—From 5 to 50 m.p.h. on high gear without choking the motor and with smooth application of power.

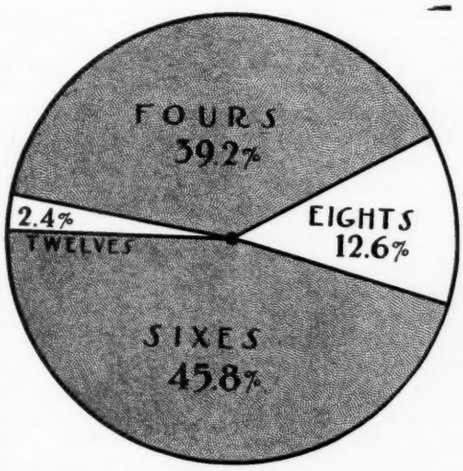
2—*Acceleration*—The ability to make a quick getaway from a standing start or to increase rapidly from one speed to another on both the high, low and intermediate gears.

3—*Comfort*—Absence of vibration and jolting due to the motor or to road inequality.

4—*Power*—Ability to climb hills, to pull through heavy roads and to travel under adverse conditions on high gear.

5—*Economy*—To be light on tires and to consume relatively small quantities of fuel and oil in consideration of the distance traveled.

All these qualities are demanded by the average owner. They are not, however, demanded by every owner. The possessor of a closed car which is to be driven about the city streets



Standing of the cylinders by models listed for the 1916 season

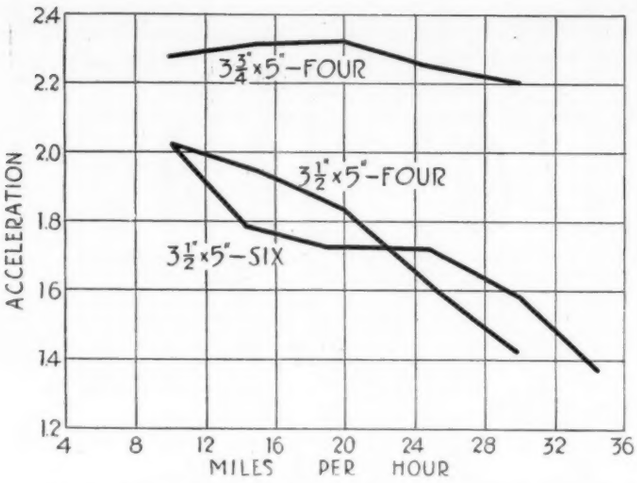


Fig. 1—Curve of acceleration on 3½ by 5 six-cylinder motor
Fig. 2—Curve of acceleration on 3½ by 5 four-cylinder motor
Fig. 3—Acceleration curve on a 3¾ by 5 four-cylinder motor

may insist that his driver never go above 20 m.p.h. On the other hand the college youth in his raceabout who has an indulgent father to pay the tire bills may scorn anything less than breakneck speed. The average owner, though, will ask for the five qualities above outlined, and if the four-cylinder can answer these better than any other type of car it will have gone a long way toward successfully defending its position.

At a joint meeting of the Metropolitan sections of the Society of Automobile Engineers and the American Society of Mechanical Engineers held in New York on the evening of April 20, two prominent engineers presented papers giving the four-cylinder side of the matter. It will be interesting to first study the broad view of the cylinder proposition and then to note what these engineers say in answer to the claims of the multi-cylinder manufacturers who have been classed as the plaintiff in this case.

The concessions have been made and each side is agreed largely as to what is demanded by the average car user. To go further into the matter than this brings the argument directly into the field of dispute, and directly into the part of the question which the jury, the buying public, must decide; for, after all, the public creates demand as rapidly as the engineer creates improvements.

Four-Cylinder Engine Is Simple

It must be conceded that the four-cylinder engine is simpler than engines having more cylinders and, if all the advantages included in the latter can be given by four, there would be no advantage in using a greater number. Again, if the advantages to be secured were only theoretical but did not work out in practice, the four would be still more desirable from the standpoint of simplicity. Therefore in studying the matter of cylinders it must be remembered that engines having more than four cylinders must show an advantage over the four in some practical respect before they are justified.

It would also be of value if it were possible to divide the entire range of automobile activity into a number of fields and then to state exactly what type of engine is most suited for that given field. There is no doubt but that a large number of automobile purchasers buy cars which are not economically the best for their purposes. They are carried away by some detail which appeals to their fancy, causing them to buy a car which is, to say the least, not adapted to their uses. It does not take 66 hp., for instance, to operate a town car over asphalt pavements with no hills at an average speed of 12 m.p.h.

As far as power is concerned, it is not necessary to go very much above 300 cu. in. to secure it. This is shown by the performance of racing cars on the speedways during the past year. On the other hand with large displacements per cylinder the stress on individual connecting-rod and main bearings is greater, and, where it becomes necessary to carry a fairly heavy car over hilly country and rough roads at high speeds, the question is one which is open to considerable doubt.

Better Acceleration on Four?

As regards the matter of acceleration, it will be noted in one of the following papers that the author claims better results for the four than for engines of more cylinders, basing his claims upon the showing of accelerometer curves and explaining them by the difficulties of carburetion in multi-cylinder engines where the gas stream is divided into a number of sub-streams running in different directions, as compared to the four where the intake stream lines are comparatively simple. Overlapping intake valve opening has been the subject of considerable engineering discussion and has had much to do with intake manifold design and also has been one of the factors in the cylinder debate. As an important consideration in acceleration and one of the reasons why the four can be made to perform as well as the multi-cylinder engine, it opens an interesting line of thought. This is particularly so because it attacks the multi-cylinder engine on one of the particular points where supremacy is claimed.

Greater Thermal Efficiency

The claim of higher theoretical thermal efficiency for the four than for the multi-cylinder engines is hardly discussed, although it is advanced by one of the engineers who presented papers on this subject. It would be possible to go back to the one-cylinder engine and show that it has a higher inherent thermal efficiency than the four. The statements regarding increased complications in multi-cylinder engines are also met in the same way, and this again brings us into the field where the jury composed of automobile-buying citizens must decide.

Piston displacement per cylinder is a theory of action which, like a blanket, may be spread to cover the ideas advanced by all parties, but it is not satisfactory as a complete answer to all those concerned. If it were true, then well-defined fields for each number of cylinders would be created by simply arranging logical divisions in piston displacements. The trouble is that the fields of the present motors overlap to a very large degree, leaving certain areas of debatable ground where the battle rages with marked and continuous severity.

The summing up of the four-cylinder case by two engineers who have clung to this type of design through all the attacks made by the promoters of cars having a greater number, is of interest, and it is particularly worthy of note to find that in many instances the attack is made on the very points in which the multi-cylinder engine has claimed superiority.

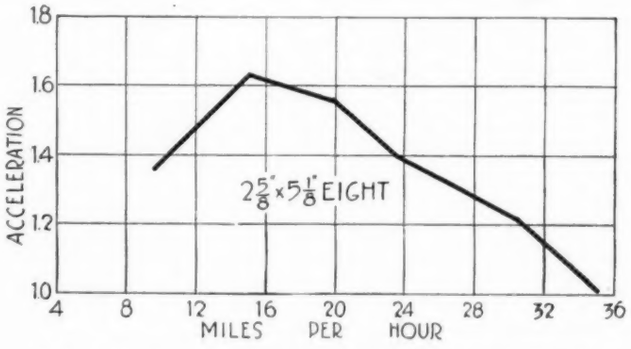


Fig. 5—Acceleration curve of eight-cylinder 2⅝ by 5⅛ motor

Automobile Applications of Four-Cylinder Motors

Paper Read Before the Metropolitan Section of the S.A.E. in Joint Meeting with the A.S.M.E.

By F. E. Watts*

THE considerations which determine the motive power for passenger automobiles differ in many respects from those which govern the selection of prime movers for any other purpose.

In the older applications of power, the problem was usually reducible to a dollars and cents basis: given such factors as work required, location, possible fuel supplies, etc.

The automobile power problem is not so definite.

During the past year numerous excellent papers have been read dealing with the technique of modern types of automobile motors. Torque variations, unbalanced forces, periodic vibrations, etc., have been called to our attention repeatedly in these papers. Most of this matter is not new; it may be found in the admirable works of Dalby, Clerk, Guldner, Lucke, Marchis and Sharpe, most of which have been available for ten years past and which are, I am afraid, lying covered with dust on our shelves.

It seems to me that much of the matter which has been presented is not pertinent, because little attention has been given as to the effect which the forces described have upon the passengers.

In this paper, therefore, I will consider briefly the applications of motors to automobiles, and will try to show why the four-cylinder motor is used on the majority of the motor cars produced to-day.

As practically all commercial vehicles, both freight and passenger, have four-cylinder motors, I will confine the discussion to pleasure automobiles.

To still further simplify the question, I will consider only the present types of four-cycle poppet valve motors.

The question to be considered then is: What is an automobile motor required to do? In other words: What is its job?

Experience gained in the building of some 50,000 cars, which are now running in all parts of the world, has convinced me that the majority of automobile owners expect their cars to perform about as follows:

To run steadily and pleasingly on high from 5 to 50 miles an hour over smooth roads.

To carry them over the rougher roads as fast as they can ride with any degree of comfort.

To pull through deep sand, mud or snow easily and without overheating.

To climb any ordinary hill where there are traveled roads, on high.

To get away from a standstill about as quickly as their neighbors' cars.

To do all these things as cheaply as possible, and without skilled care and constant attention.

Naturally the motor's part in securing this performance is important, but I think that anyone will grant that the average automobile owner is not greatly interested in the construction or performance of his motor except as it affects the performance, durability and maintenance cost of his car.

Let us consider these three factors in the order mentioned.

Performance

The horsepower required to give the performance just outlined depends of course quite largely upon the loaded weight of the car. This in turn depends upon the passenger capacity and the comfort desired.

In a practical way it is generally understood that the comfort of the passengers is increased as the ratio of sprung to unsprung weight is increased, and as the ratio of sprung weight to each passenger's weight is increased. I have never seen any mathematical proof of this proposition, but with equal quality of design and workmanship I think it is the general experience.

On this basis we may divide cars carrying from five to seven passengers roughly into three classes: First, cars of toleration, having a shipping weight of less than 1800 lb. Second, cars of comfort, having a shipping weight of from 1800 to 3000 lb. Third, cars of luxury, with a shipping weight of more than 3000 lb. There are, of course, notable exceptions to this classification. All cars of the first class manufactured in quantity have four-cylinder motors, and there appears to be little doubt but that they will continue to use this type.

It is in the second class that the controversy as to the proper type of motor to use is most active at the present time. Cars of the second class include quite a range of vehicle sizes. As the horsepower required varies with the loaded weight we find motors in cars of this class which vary from a little more than 20 hp. to a maximum of somewhat more than 50 hp. Most of the motors are included in the range between 25 and 40 hp.

However, the horsepower of a motor is not always an indication of its availability for automobile use. Often the maximum torque and the range of this torque are the determining factors. The maximum torque of the motors which I have just mentioned will usually run between 1250 and 2000 pound-inches. I say that the maximum horsepower does not always decide the availability of the motor for use in ordinary pleasure cars for the reason that the speed of these cars should be limited to from 55 to 60 m.p.h., and if the maximum horsepower of a motor is obtained at such a high

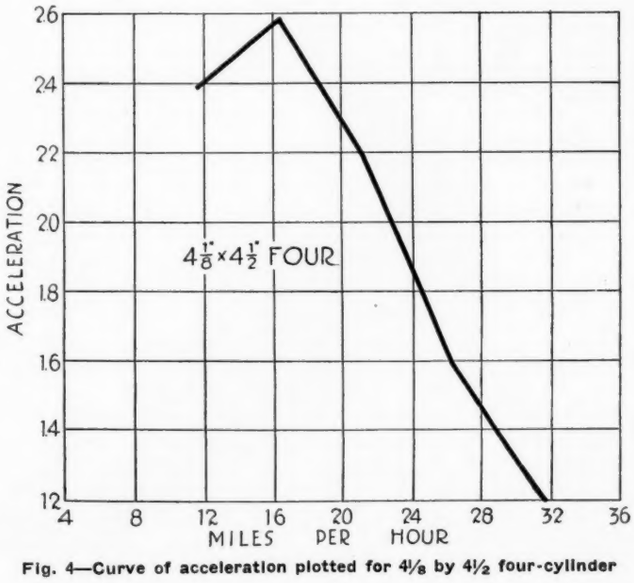


Fig. 4—Curve of acceleration plotted for 4⅛ by 4½ four-cylinder

Chief Engineer Hupp Motor Car Corp., Detroit, Mich.

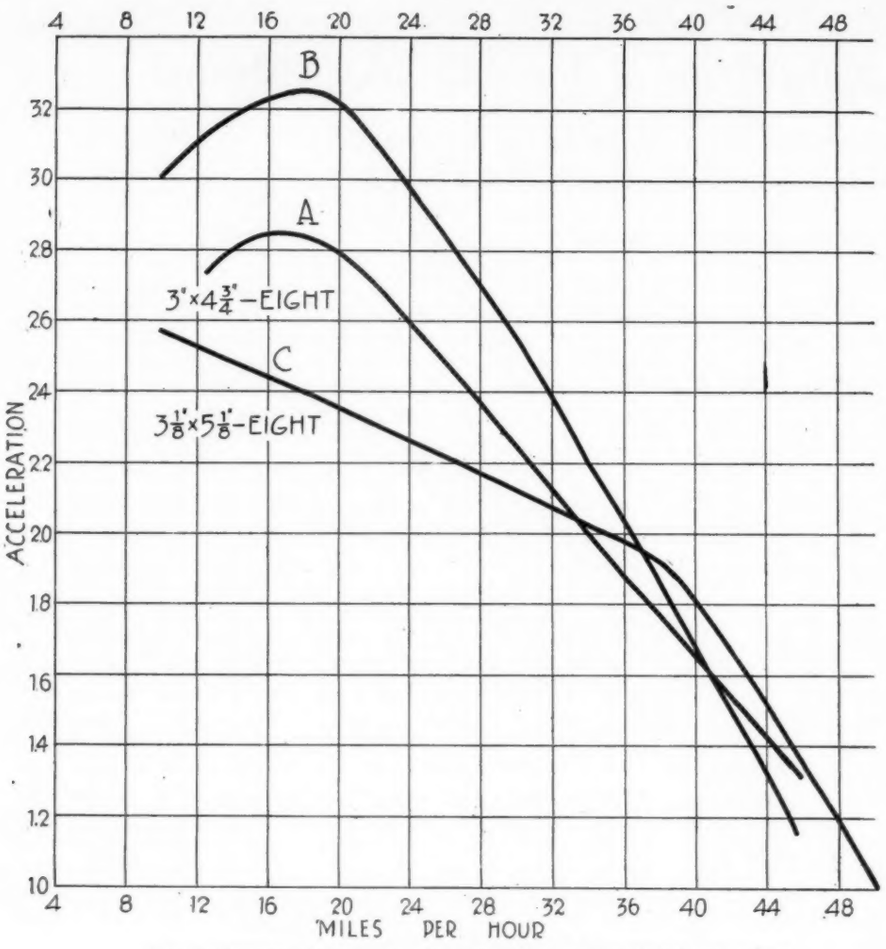


Fig. 6—Comparative curves of acceleration on two eights and a four

number of revolutions that it will not be usable at this car speed with a practical rear axle ratio, it is not of any practical value.

Acceleration Ability Increased

At the present time the horsepower required is quite often determined by the acceleration demanded. Within the last year there has been a tendency to greatly increase the ability for acceleration in motor cars. This has been due partly to the advent of eight- and twelve-cylinder cars, and to rather extravagant claims of salesmen as to the ability of these cars. I believe it is also partly due to the increasing congestion of traffic in our large cities and upon our principal highways, or to other traffic conditions which make a quick getaway very desirable.

It may be desirable in this connection to show some curves taken with the Wimperis accelerometer.

Fig. 1 shows the acceleration curve of a very popular six-cylinder car, 1915 model. You will note that the acceleration at 10 m.p.h. is slightly over 2. This car was considered very satisfactory at the time it was built and was sold in large quantities.

Figs. 2, 3 and 4 show acceleration curves of well-known and popular makes of four-cylinder cars, also 1915 models. These show accelerations which, while slightly greater than the six-cylinder mentioned are very closely comparable with it.

Fig. 5 shows the acceleration curve of a well-known eight-cylinder European car, which was built especially for city work. The acceleration of this car is noticeably low, but it must be remembered that it is the custom abroad to change gears much more frequently than in this country, and this car was fitted with a transmission having four forward speeds.

Fig. 6 shows a comparison of three more recent cars. Cars *A* and *C* have eight-cylinder motors and car *B* has a four-cylinder motor. I believe that the acceleration of car *B* at ordinary driving speeds is about as great as is obtained with any stock car fitted with standard gear ratio, at the present time.

Fig. 7 is a test of the same car as *B* in Fig. 6, but in this test the second speed gear was engaged. The rear axle ratio, however, was 4 to 1, whereas with the standard car this ratio is 4.64 to 1.

A considerable experience in acceleration tests of stock models of American cars purchased in the open market leads to the following conclusions: At the present time the best acceleration, and by this I mean the most available for use in traffic conditions, is obtainable from four-cylinder motors. The acceleration of other types of motors at the slower speeds is not usually as quick or as powerful as the acceleration of the four. At speeds of from 15 to 20 m.p.h. and above the different types become very nearly equal, and at speeds of more than 30 m.p.h., motors having a large number of cylinders are better than the four. This is particularly true of six-, eight- and twelve-cylinder motors having single carbureters, which are apt to be rather uncertain in very low speed action when picking up quickly. The result often is that the more cylinders a motor has the more frequently one is required to use the gearshift lever for city driving. I do not believe that this is fundamentally necessary. It is probably due to imperfect carburetion and poor distribution of gas, and will in all probability be remedied.

The next point which should be discussed in comparing the performance of cars with the different numbers of cylinders is the question of smoothness of operation.

Fours Are Greatly Improved

For very rapid acceleration cars having four-cylinder motors are not quite so smooth in action as those in which the power impulses are more frequent. But recent changes in four-cylinder design, the remarkable lightening of reciprocating parts, the more rigid construction of revolving parts, and above all the very much greater rear axle gear ratios, which the use of spiral-bevel gears has made practical, have entirely revolutionized the performance of modern four-cylinder motors as compared to those built even one or two years ago.

At the present time, while the difference between a four and a six, eight or twelve can be detected on rapid acceleration: it can be detected by the average driver only if he is really trying to detect the difference. It is not noticeable to the average driver, unless he is especially looking for it, at any rate of acceleration he will care to pay for. I believe that the desirable limit in acceleration has about been reached, for we have already reached a point where the wear upon tires and the consumption of gasoline is excessive, and I do not believe that the public will long continue to pay for such high activity.

The next point in comparing smoothness of operation is the comparison of low-speed running. In this respect the manufacturer of a modern four-cylinder car having a rear axle gear ratio greater than 4.50 to 1 need have no hesitancy whatever in comparing his product with any car made. Cars having six-, eight- and twelve-cylinder motors will give a better performance at low speeds when the motor is suitably adjusted and carefully tuned for the test, but it is the almost universal experience of car owners that it is difficult to keep the ultra-multicylinder motor tuned to the point where it will give a demonstrating low speed performance. It is only upon the cars whose owners take exceptionally good care of them, or which are driven and cared for by unusually good chauffeurs that the low-speed advantage of many cylinders becomes apparent. A great deal has been written regarding over-lapping power impulses of six-, eight- and twelve-cylinder motors, without taking into consideration the fact that before these impulses are transmitted to the driving mechanism of the car they are absorbed by the flywheel, and that by suitably proportioning the flywheel great smoothness at slow speeds can be obtained with few cylinders.

High-Speed Possibilities

Going from one extreme of the motor performance to the other, let us compare the high-speed possibilities of the different types. It would seem that in this direction motors of a great number of cylinders should be pre-eminent, but up to the present time at least they do not appear to have proven so. Apparently the most efficient high-speed motors made up to the present time are the multi-valve four-cylinder motors having four valves per cylinder placed in the head. I have had no personal experience with motors of this type, and can judge only from published records of track performance. In touring car motors, however, the high-speed possibilities of the four appear to be well beyond all ordinary requirements. Reciprocating parts of touring car motors have decreased in weight remarkably within the past few years. Several years ago I found the reciprocating weights in pounds per square inch of piston area to be about 0.4 lb. At the present time they have been reduced to about 0.2 lb. As the formula for inertia forces due to reciprocating weight is $\frac{F}{a} = .00034\frac{W}{a}N^2 r\ (Cos\ \theta + a, Cos\ 2\ \theta)$* the inertia forces of the average motor have been reduced 50 per cent for an equal number of revolutions. Internal forces due to speed have been reduced proportionately and the possibilities for high speed are apparent.

Improved lubrication has also done wonders, and quite recently the matter of counterbalancing crankshafts, which practice has long been followed abroad, has been brought forward prominently in this country. Though considerable friction reduction may be possible in complicated forms of crankshafts, such as are used in many of the six- and twelve-cylinder engines, but little is accomplished by applying counterweights to four-cylinder crankshafts for ordinary touring car speeds.

Friction Tests

Friction tests of four-cylinder motors show no marked improvement below 2500 r.p.m. At very high speeds there is a probability that counterweighted crankshafts show up to better advantage, but such high speeds are not encountered in practice on ordinary touring cars.

Fig. 8 shows the relation of car speeds in miles per hour and engine speeds in revolutions per minute with 5-to-1 rear axle ratio and 32-in. tires. At the present time I do not believe it is desirable for large quantity production to go much beyond a 5-to-1 rear axle ratio even with spiral bevel gears. If the ratio is carried beyond this point, either the diameter of the driving gear must be increased so that the road clearance is reduced below what is desirable, or the size of the pinion becomes so small and the unit pressure on the teeth so high that it is difficult to obtain adequate lubrication of the teeth. This means rapid wear in districts where the cars are subject to hard service, as they are in some of our western states, and it also means that an unduly large number of axles must be turned back for re-adjustment, or for lapping of gears. Or the gears must be rejected altogether on account of noise. The only alternative, if the gears are made large, is to increase the diameter of the tires, which partly nullifies the effect of the increased gear ratio.

At the present time worm-driven rear axles are out of the question for large quantity production, as the cutting of successful worms has not yet reached the large quantity production stage. I believe therefore that a well built L-head four-cylinder motor of standard design is still plenty fast enough for touring car work.

It is, however, at medium speeds of running that the question as to whether or not a motor has objectionable vibra-

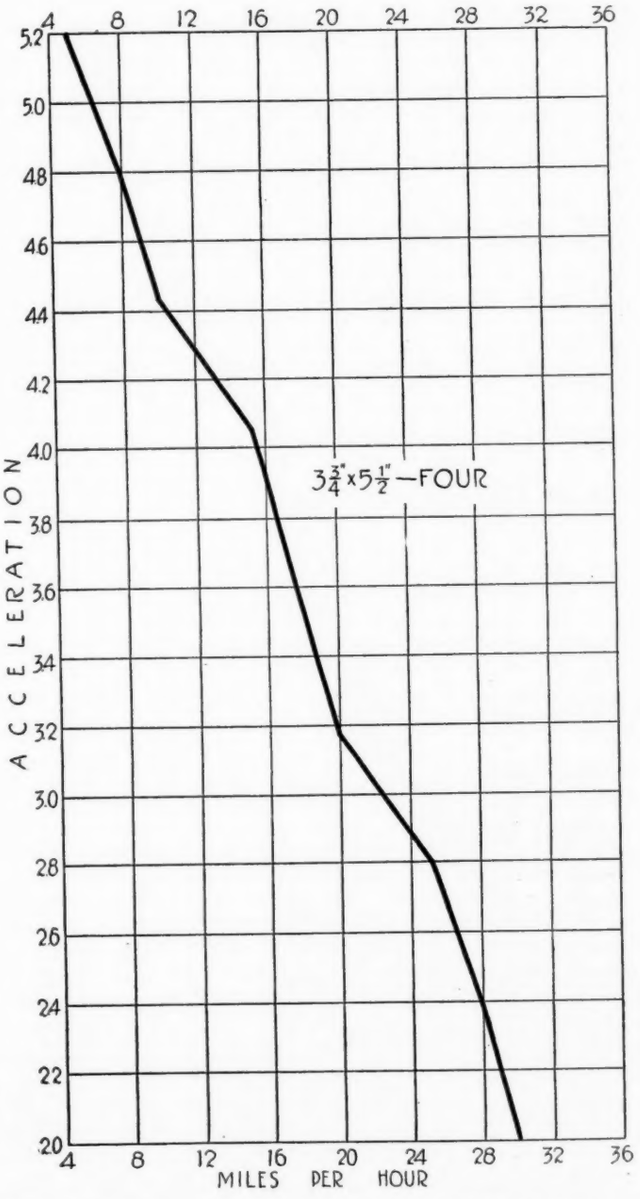


Fig. 7—Second speed gear acceleration curve on a 3¾ by 5½ four

*For derivation of formula see "Gas Engine Design," by C. E. Lucke, p. 82.

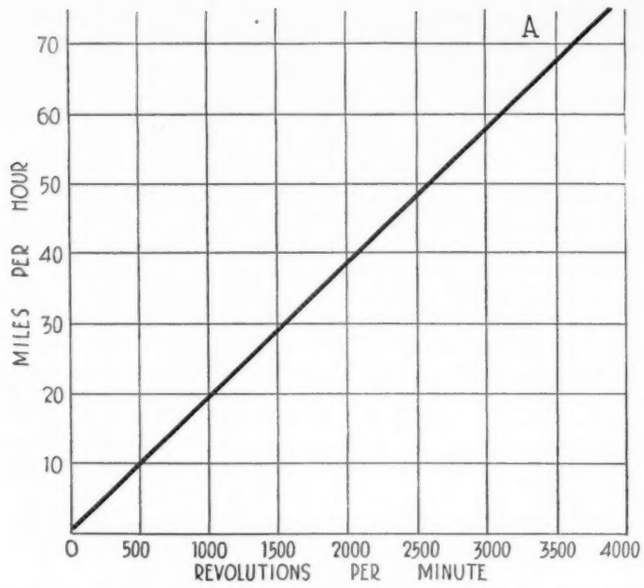


Fig. 8—Curve of m.p.h. against r.p.m. for 32-in. wheel at 5 to 1 ratio

tions becomes most important. Motor car vibrations which affect the passengers' comfort may be divided into two classes: First, those caused by the road surface; second, those caused by the motor. The former are of course the most disagreeable, and unfortunately they are also the least controllable. Vibrations due to the motor are largely controllable by the design of the car. It is, I think, almost universally recognized that the vibrations caused by a well-designed four-cylinder motor with light reciprocating parts are negligible at slow speeds. It is not however generally recognized that it is possible to reduce the vibrations at any speed so that they are comparable to the vibrations at slow speeds. However, the fundamental formula for the vibrations of a four-cylinder motor is: $D = C\frac{rw}{W}$

Where D = Displacement of engine from its normal position.
C = a constant.
r = crank radius.
w = weight of reciprocating parts.
W = total weight of the engine.†

It will be noted that the speed does not enter into this formula. This is due to the fact that while the forces which cause vibrations increase with the motor's speed, the time in which these forces act in a given direction to produce vibration decreases directly with the speed, hence the decrease of the time factor exactly offsets the increase in the force factor, and leaves the tendency for the motor to vibrate exactly the same regardless of speed. This theoretical consideration would be true in practice if all the parts of the motor were perfectly rigid, if it were mounted upon a rigid support, and if the time of vibration of the support did not synchronize with the motor vibrations at any speed. In practice, neither of these assumptions is quite true, but it is possible by making the reciprocating parts light, the crankshaft and other revolving parts rigid, and by suitably proportioning the frame and spring supports, to reduce the vibration of a four-cylinder motor very remarkably. Then, too, the synchronous vibrations are not by any means limited to four-cylinder motors. They are likely to be even worse in six- and twelve-cylinder motors on account of the more complicated forms of their crankshafts. Sixes, eights and twelves are likely to give more trouble from vibrations of the higher periods than are fours, and these vibrations are likely to manifest themselves unexpectedly in parts of the chassis which are distant from the motor. Means of overcoming such high period vibrations are the subject of study at the present time.

It is not fair to compare the running of a modern multi-cylinder motor with an old style four as is so often done. When they are compared with fours of recent design, little difference will be detected.

†For derivation of this formula see: Horseless Age, Vol. 21, p. 513, or "The Balancing of Engines," by Archibald Sharpe.

Durability

The question of durability may be divided into two parts: First, the durability of the motor; second, the durability of the running gear, body, etc.

As to the motor, each part can be made as ample for its work in one type of motor as in another, but the four-cylinder motor should have a longer life than the other types, for it is primarily more accessible and easier to care for, hence it gets the better average attention.

The efficient life of a good motor is much longer than that of the average chassis on American roads. Ordinarily, springs wear out first, then the body, and the other sheet metal parts, then the frame, then the axles, and last of all the motor. The effect of the type of motor on the life of the remainder of the chassis is debatable. The different motor types have not been in use long enough so that we can be sure as yet. We do know that many chassis stresses increase substantially as the square of the car speed, so high speed naturally tends to wear a car out fast. This is the strongest argument for limiting the maximum speed of the car to what I have mentioned. Given equal maximum speeds, road shocks, dirt, and weather effects are the all important factors in chassis wear, so far as I can determine. The slightly greater vibration of a good four-cylinder motor does not seem to be factor enough to be worth considering.

The effect of the greater shocks possible to the driving mechanism from the inertia of the heavier flywheel of a four-cylinder engine can be modified to any extent desired by a suitable clutch design. I believe therefore that a car with four cylinders is as durable as one with more, and that the motor is more durable.

Maintenance Cost

It is an axiom in all mechanical work that the less complicated a machine is, the lower must be its maintenance cost. Now where is this more apparent than in the comparison of the four-cylinder motor with other types? It is more accessible than other types. It has fewer parts in proportion as it has fewer cylinders. Repairs required are not only less frequent than in other types of motors, but they are less costly to make. There are less valves to grind; less cylinders to decarbonize; less spark plugs to clean; less ignition wires to watch for leaks, breaks, short-circuits and static effects; less ignition contacts to synchronize; less work of all sorts to do. Of course this greatly decreases the maintenance cost to the owner, or the time he has to spend in getting his motor in condition if he does the work himself.

As to fuel consumption, the four-cylinder motor is fundamentally superior to other types. In any type of fuel distribution used in motor cars to-day, the division of the gaseous steam decreases efficiency. The single cylinder is the most economical type; and the fuel efficiency decreases as the number of cylinders increases. The public is often misled by certified tests which are made on carefully tuned and adjusted cars, but the result in the hands of the owners is the only thing that will count ultimately. Naturally the rising cost of fuel has caused extravagant statements as to fuel economy, which are made in many advertisements, but unfortunately, for the most part these statements are not borne out in every day practical experience.

The designers of ultra-multi-cylinder motors are now busily at work on much smaller motors, utilizing very high compression, and it will be interesting to see what they can do in this direction. This matter of increased compression was tried out about ten years ago, and finally abandoned, but with the increased technical skill available at the present time, and the smaller cylinder sizes, it is possible that something may be accomplished. It is, however, doubtful just how much can be done with our present motor car fuel, for at the present time the gasoline available tends to partake more and more of the nature of kerosene, and does not lend itself exceptionally well to high compression.

Fig. 9 shows a recent test along these lines. The lower curves marked *A* and *B* are compression curves taken from the same motor using two different sets of pistons. The corresponding upper curves show the brake mean effective pressure obtained from the two tests. It will be noted that it takes a considerable increase in compression to get a slight increase in mean effective pressure, particularly at the lower speeds. It was also found that the motor with high compression did not operate as smoothly as the motor with the lower compression. I believe that motors having very high compression, while they may show better fuel economy on the dynamameter and in the hands of careful users, will not prove satisfactory for the use of the general public. Possibly however, other methods of using liquid fuels will solve this problem.

Summary

For cars of the first and second classes I do not believe more than four cylinders are desirable, because in the hands of the average user a modern four-cylinder car will do anything he requires, as pleasantly as any other type, and will do it cheaper. This being so, more than four cylinders are not justified.

In cars of the third class, however, a different condition arises. Here the demand for luxurious appointments and high-speed possibilities make the cost of the motor a much smaller percentage of the total cost of the car. The operating cost also is not so important. And as the weight to be moved is greater, the ultra-multi-cylinder motor has its place. This is its only proper field of automobile application, and I venture to predict that five years from to-day 75 per cent of the money being spent for pleasure cars will go for the purchase of four-cylinder machines.

This is of course a mere matter of opinion. The buying public is the final judge. Their verdict will not depend upon technical arguments but will be based upon practical performance. What it will be is not a question for calculation but rather for the application of common sense.

Internal Combustion Motors

The Four-Cylinder Motor of To-day and Future Possibilities

By F. R. Porter*

TO keep a discussion of the internal combustion motor within the scope of this paper and still have it interesting and instructive seems quite a task. Available data is so varied and conflicting as to the object in view, that it becomes almost worthless for a matter of comparison. From this volume of apparently haphazard experimental data however, we have established a few facts that are now common knowledge, some of which stand out as unconquered points, resulting in hundreds of failures, while others represent confirmation of well-directed research work.

The subject of the Otto cycle motor, like most others of a basic nature, was really beyond the inventor; while he established a point of superiority in motive power, he had no conception of the scope of his subject.

Early experiments soon established limiting factors that controlled the power output of a single cylinder, and made the duplication of units necessary. The apparent possibilities together with the extremely interesting side of the subject produced a demand in advance of the art, resulting in more duplication of units; at the same time attracted the attention of metallurgists and chemists, with the result that the limiting factors assumed new values; some of them, as a result of better material and more appropriate accessories being developed, disappeared almost entirely.

Limiting Factors Are Few

To-day, the limiting factors so far as mechanical ability is concerned are very few and as a rule are well understood. The one that comes nearest to determining the possible power output of a single cylinder is the matter of piston areas.

The extreme heat conditions that pistons are subjected to limit the amount of area exposed to the amount that can be kept down to the proper temperature by heat flow to the cylinder walls. While this factor varies according to the m.e.p., it has been pretty well established at about 16 sq. in., which represents a bore of 4½ in.

Piston speeds are apparently governed by the ability of bearing metal to withstand the inertia forces. While different materials may be employed to decrease these forces, surface friction becomes a considerable factor at very high speeds, so that the practical speed in feet per minute has been established at approximately 3000. Bore to stroke ratio is purely a matter of choice, but is generally accepted as more conducive to thermal efficiency as the ratio increases; two to one, however, seems about the limit.

Compression pressures close to the point of pre-ignition are had almost universally when extreme power output is needed. While the volumetric efficiency controls somewhat the possible ratio of clearance to displacement, five to one is generally accepted, and represents approximately 100 lb. gage.

M.e.p. follows volumetric efficiency almost in direct proportion, the absolute being about 40 per cent above the com-

(*Continued on page* 791)

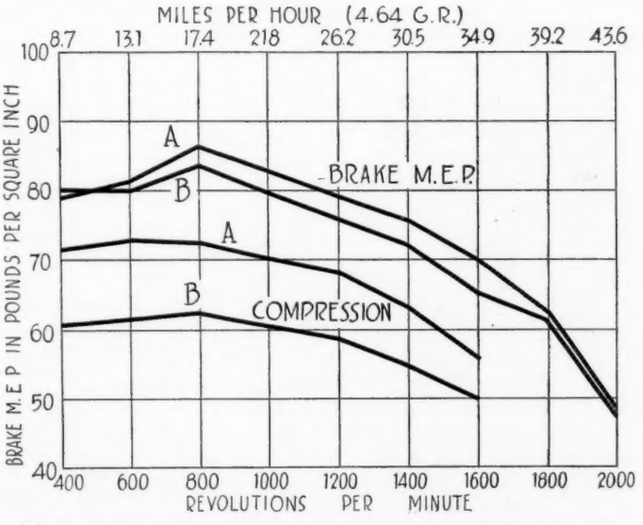
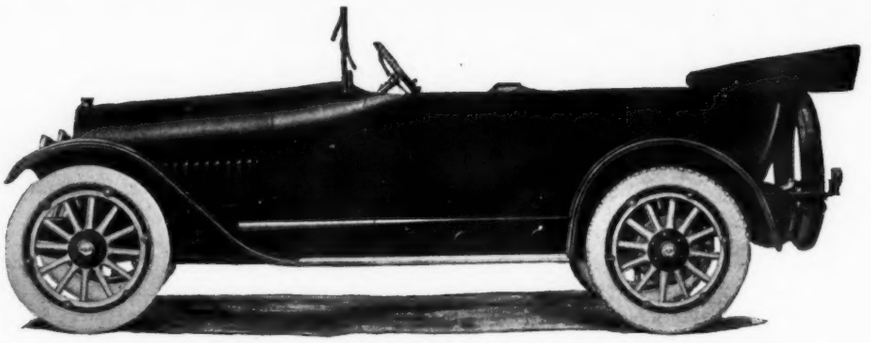


Fig. 9—Brake mean effective pressures and compressions for two piston lengths

*President Finley Robinson Porter Co.

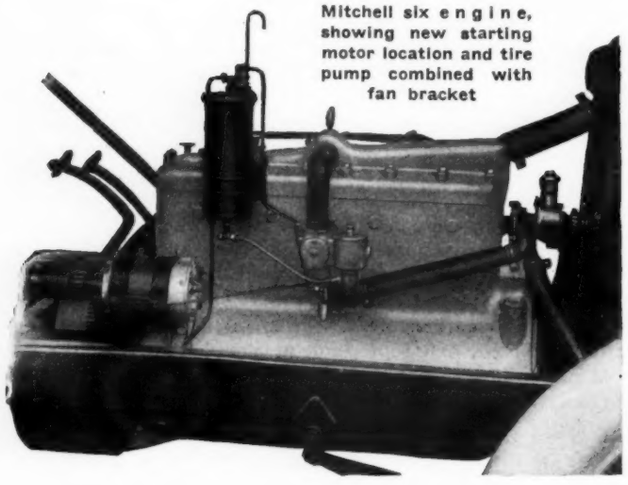
Better Bodies in Mitchell New Six

Lines Improved by the High Radiator—Engine and Chassis Refined

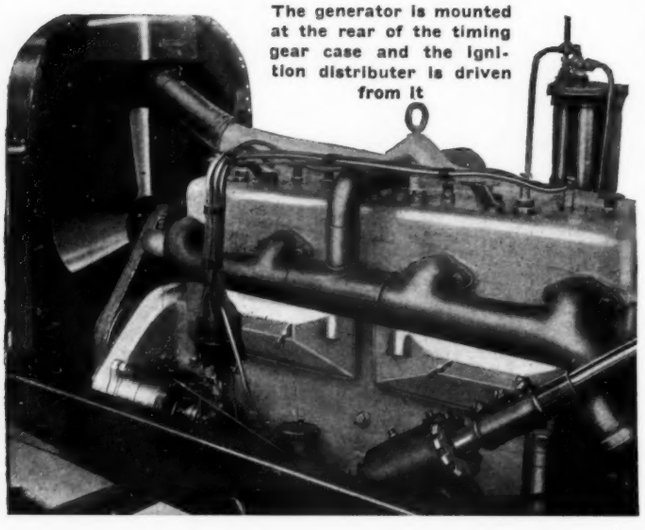


AS announced in THE AUTOMOBILE last week, the new model of the Mitchell Six, built by the Mitchell-Lewis Motor Co., Racine, Wis., is larger, roomier and more attractive in appearance than its predecessor, the Six of '16. The wheelbase has been increased 2 in. to 127 in. by increasing the length of the rear cantilever springs and changing other dimensions to correspond, the waterjacket of the 3½ by 5-in. high-speed block motor has been carried lower on the cylinders, accessibility has been improved and numerous other detail refinements have been made. Some of the most interesting developments, however, are in the body design.

In appearance, the new Mitchells are exponents of the latest in body design, having a high, narrow radiator and smooth, sloping hood, which is well rounded at the top, the rear part having suggestions of boat lines, together with a defined cowl at the back of the front seats. Accompanying the improvement in appearance and increase in the size of the car there has been an increase in price of $75, making the five and three-passenger $1,325 and the seven-passenger $35 additional.



Mitchell six engine, showing new starting motor location and tire pump combined with fan bracket



The generator is mounted at the rear of the timing gear case and the ignition distributer is driven from it

A feature that will be appreciated is that, like some other cars of its class, the five-passenger touring car in every respect is a duplicate of the seven except for the addition of the two spare seats, so that should the purchaser wish to increase the capacity of the five-passenger car he can obtain a seven-passenger in every respect like factory production by the installation of the additional seats which may be obtained later for $35. These seats, by the way, are the disappearing type and fold completely out of sight.

The forward seats, while having no space between them, are divided by a small arm which forms a shoulder rest for both occupants but does not interfere with entrance or exit to the driver's seat. Two little items which indicate the extent to which comfort has been considered are the glove compartment in the instrument board and the tonneau light on the back of the forward seat. Within the instrument board there is fitted a new compartment in which small traveling requisites may be carried and which is locked by the same key that operates the ignition lock. The tonneau light is provided with a push switch which can be operated by the tonneau passenger.

Engine Jacketing Improved

In the design of the block 3½ by 5 in. motor there has been but little alteration. The chief one is the extension of the waterjackets to a very much lower point on the cylinders, giving the engine a more symmetrical appearance as well as providing cooling surface, or water surface for more excessive demands than previously.

The engine is designed to be of the high-speed type and with this end in view special pains have been taken in balancing and lightening the reciprocating parts. The pistons are drilled to decrease weight, and also are provided with piston rings in the two lower grooves, which are made up of four special steel rings, to eliminate loss of compression. The top ring is of the ordinary iron construction. Small holes drilled through the machined oil grooves around the pistons allow the surplus oil to flow back into the crankcase.

The cylinders are L-head, cast in block and integral with the crankcase. This is designed to give rigidity to the motor and reduce vibration. The cylinder head is a one-piece casting, held in place by means of three rows of bolts and a leak-proof fit is assured by the use of a one-piece, copper-asbestos gasket. The cylinder heads can be removed without disturbing any other part of the engine. The crankcase is of the barrel type, the lower half being formed by a light, seamless, steel stamping, which is divided into two compartments, the upper fitted with overflow openings, and troughed for the connecting-rod spoons. The lower compartment comprises the oil reservoir.

The crankshaft has three bearings, and is offset ½ in. from the center of the cylinder. The gears which drive the cam-

shaft, ignition distributer and tire pump are inclosed in a housing which is a part of the crankcase. Gears are lubricated by a separate oil lead and have helical teeth. The lubrication is a combination of circulating and splash, the circulation being maintained by a plunger pump operated by an eccentric on the camshaft. Oil is pumped from the reservoir in the crankcase to the compartments under each connecting-rod, and also to the timing gears in the front. A small quantity of oil is carried to the clutch bearing as well. A unique idea is carried out in the oil indicator. In place of the usual sight feed on the dash, the Mitchell has a plunger type, operated by the oil pressure. This consists of a small rod which protrudes from the dash, proportionately to the pressure of the oil in circulation. In addition to this, an oil level indicator is provided on the crankcase. Push rods and valve stems are supplied with an oil vapor through breather openings into the crankcase.

Fan and Water Pump Combined

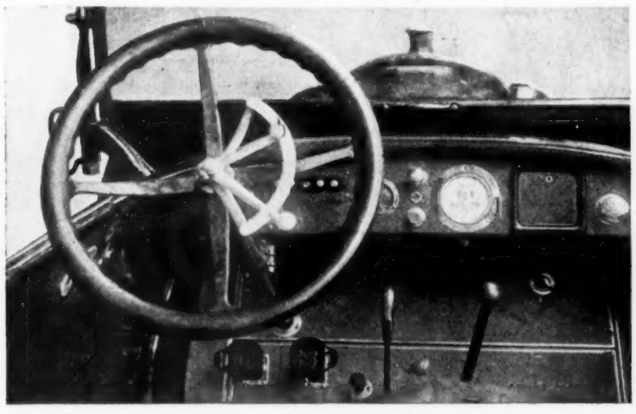
Another unusual bit of design is in the combination of fan and water pump, at the front end of the motor. Instead of mounting it on a lay shaft, the pump, which is a centrifugal type, is mounted on the fan shaft and thus is driven by the fan belt, which is made of endless fabric. Adjustment is provided by a wing nut. This swings the entire fan and pump assembly upwards and thus tightens the belt. The integral fan and pump bracket also forms the outlet for the water pump, thus simplifying the construction to a point where only one hose connection to the pump is necessary. As stated, the waterjackets have been carried down, so that they have extra capacity around the exhaust valve seats.

Ignition is taken care of by a storage battery and an automatic circuit breaker and distributer of the single-unit type, which is driven through a worm gear from the timing gears of the motor. The high-tension wires to the plugs are carried over the engine with special supporting bracket, which prevents chafing and leaking.

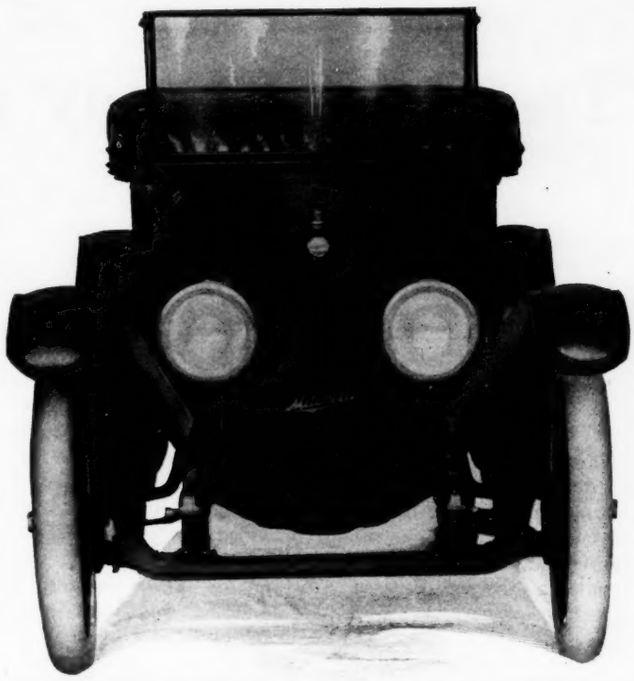
Integral Intake Manifold

The carbureter is a Rayfield mounted on the right side of the motor. The intake manifold is cast inside of the cylinders, and passes between the middle cylinders from the carbureter on one side to the valves on the other. Fuel is supplied from a tank at the rear by the Stewart vacuum system. Within the flywheel is a cone clutch, which is made up of a stamped-steel spider faced with chrome leather, and having auxiliary springs. Adjustment is provided by three nuts.

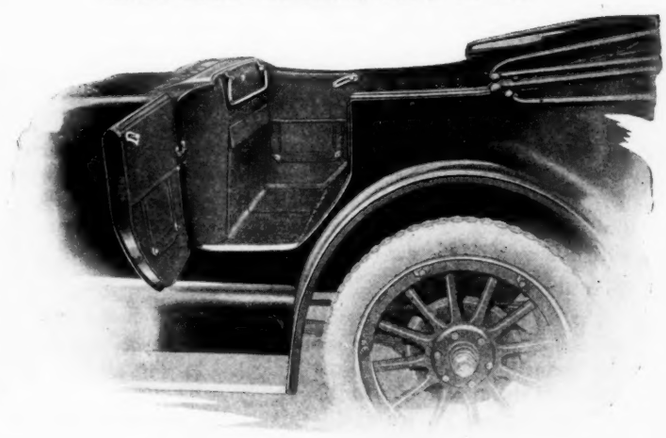
Mechanically the alterations have been more in the way of slight changes in the motor which work for increased accessibility. This feature of accessibility is one characterized in the Six of '16 and Mitchell engineers have progressed still further in the new model. To this end the single-unit starting system which was a part of the design in the earlier six has given way to the Westinghouse two-unit system in which the generator and distributer are driven off the same shaft on one side of the engine while the starting motor operates through a Bendix drive to teeth cut on the flywheel. This eliminates the silent chain, which was a part of the starter-generator drive in the previous motor.



A feature of the Mitchell instrument board is the glove compartment



The front view of the new Mitchell six gives an excellent idea of the improved appearance in the body design. Note the high, narrow radiator and sloping lines of the hood



The tonneau door is wide and there is a light in the tonneau cowl

The 2 in. increase in the wheelbase brings this figure up to 127 in. This has been made possible by lengthening the cantilever springs 2 in. Last year these cantilevers were underslung and have been one of the factors in making the Six of '16 an unusually easy riding vehicle. Along with the increase in the length of the springs, the number of leaves have been correspondingly increased.

The engine-driven tire pump has been elevated to a point where it can be gotten at easily and is now mounted immediately behind the fan and driven by a gear on the fan shaft.

Demountable rims, with 34 by 4 tires, anti-skid, on the rear, power tire pump, one-man top and dimming headlights, are among the features of equipment.

Tracing the Why of Carbureter Parts

Cleveland S. A. E. Hear Paper Explaining Functions of Compensating Jets and Air Valves—Diagrams Show Exact Effects of Alterations in Design

By F. H. and F. O. Ball*

THE laboratory used in the investigations here reported contained a gasoline motor and an electrical equipment for loading the motor, also a metering outfit for measuring the gasoline and air used by the carbureter under all conditions. A steam ejector was arranged to be used as another means for drawing air and gasoline through the carbureter. A water column provided the means for observing the suction or head which impelled the flow, thus furnishing the data necessary for plotting curves showing the quantities of gasoline and air discharged at each head.

The Law Governing Flow

Contrary to a somewhat prevalent opinion, the same law governs the flow of air and of gasoline through a fixed orifice and the quantities discharged in both cases vary as the square root of the suction or head. This law does not hold good at extremely high velocities, but throughout the range covered in carbureter practice it may be accepted as approximately correct. It follows, therefore, that in a fixed orifice carbureter, if the flow of gasoline and air begin at a common zero, the ratio of one to the other, at any point, will be the ratio throughout the whole range of working capacity.

In practice it is not desirable to maintain the gasoline level at the overflowing point in the discharge nozzle, therefore the zero of the gasoline curve of flow does not coincide with the zero of the air curve.

Quantity Curves

The foregoing is illustrated in Fig. 1, in which the suction or head is indicated by the scale at the bottom of the chart. The quantities of gasoline are indicated by the scale at the right and the air scale is at the left.

These curves, as drawn in this case, indicated that the capacity of the respective orifices was such that with a suction equal to 20 in. of water, 10 oz. of gasoline were discharged per minute and 100 cu. ft. of air. This ratio has been found to be a strong, clean burning mixture. It corresponds approximately to 12 lb. of air to 1 lb. of gasoline.

Referring again to Fig. 1, it will be noted that the air curve and gasoline curve do not have a common zero and therefore the ratio of gasoline to air, at different points on the curves, is not constant.

Quality Curves

The actual ratio of gasoline to air, under the conditions shown by the quantity curves of Fig. 1, is clearly shown in Fig. 2. Here the horizontal scale is in cubic feet of air per minute and the vertical scale in ounces of gasoline per 100 cu. ft. of air. The right-hand end of the quality curve indicates 10 oz. of gasoline per 100 cu. ft. of air and corresponds with the right-hand end of the quantity curves of Fig. 1 where they coincide. Progressing backward toward zero, the quality curve of Fig. 2 shows the effect of the difference in the zeros of the two quantity curves of Fig. 1.

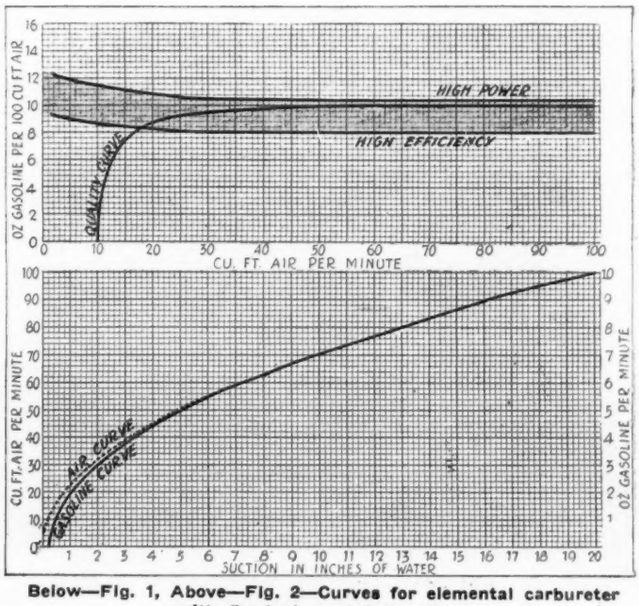
The shaded zone in Fig. 2 covers the range of quality within which it has been found desirable that the quality should be maintained by the carbureter.

The boundaries of this zone may not be universally accepted as the best, but that is a matter of no importance because they are at least approximately the best and the zone is entirely satisfactory as a field in which to plot the characteristic quality diagrams of various types of carbureters for comparison.

Referring to Fig. 2, it will be seen that when less than 18 cu. ft. of air per minute is being drawn through the carbureter, the quality passes outside the desirable zone.

This makes it impossible to enrich small quantities of air. Therefore, the elemental fixed orifice carbureter cannot be used with success, and it becomes necessary to embody in the carbureter some means for augmenting the gasoline supply where it is deficient. Various devices are used for this purpose. Some affect the necessary compensation by acting on the gasoline supply, others act on the air and still others on both.

It is proposed to illustrate and analyze the effect of the most important of these devices, selecting those which have been the most extensively used in high grade instruments. This analysis is made solely for the purpose of showing the effect of the various devices in maintaining a normal quality to a lower minimum quantity than is possible with the elemental fixed orifice carbureter as shown on Fig. 2. In this analysis no attention is paid to the relative maximum capacities nor to any other question relating to the several types of carbureters. These other questions will be considered separately in connection with quality diagrams made by actual carbureters of the several types that are being theoretically analyzed.



Below—Fig. 1, Above—Fig. 2—Curves for elemental carbureter with fixed air and fuel orifices

*Penberthy Injector Co.

Figs. 9, 11, 12, 15 and 17 of original paper are omitted as their character is well described in the text.

This carbureter differs from the elemental fixed orifice carbureter in that it is provided with supplemental or compensating devices which increase the supply of gasoline, particularly at that part of the quality diagram where it is most deficient.

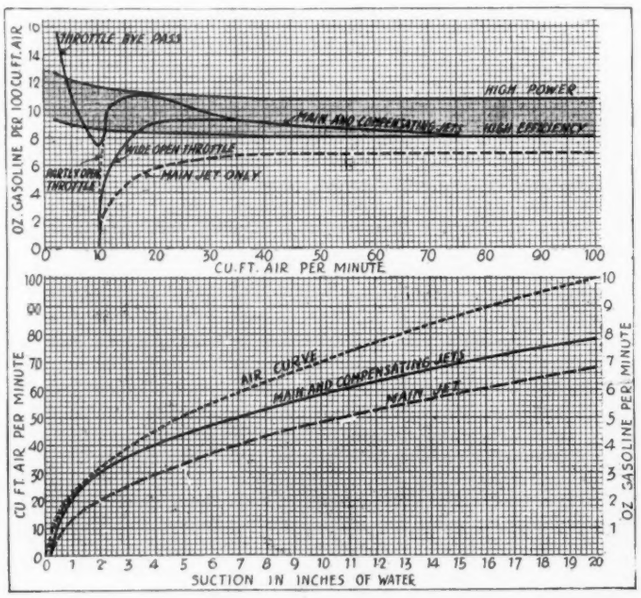
Figs. 3 and 4 illustrate and analyze the effect of these compensating devices. In Fig. 4 the quantities discharged by the main jet under various amounts of suction will be found along the main jet quantity curve.

The quality produced by these quantities is shown on Fig. 3 along the curve marked main jet only. Referring again to Fig. 4, a second supply is drawn from a well open to the atmosphere and supplied with a constant quantity of gasoline from the float chamber by gravity. The total quantities of gasoline from this double supply are indicated by the curve marked Main and Compensating Jets in Fig. 4, and the effect on the quality is indicated in Fig. 3 by the curve marked Main and Compensating Jets. It will be noticed that the quality curve branches and that the two branches marked Partly Open Throttle and Wide Open Throttle come together at a common zero. This will be explained further on.

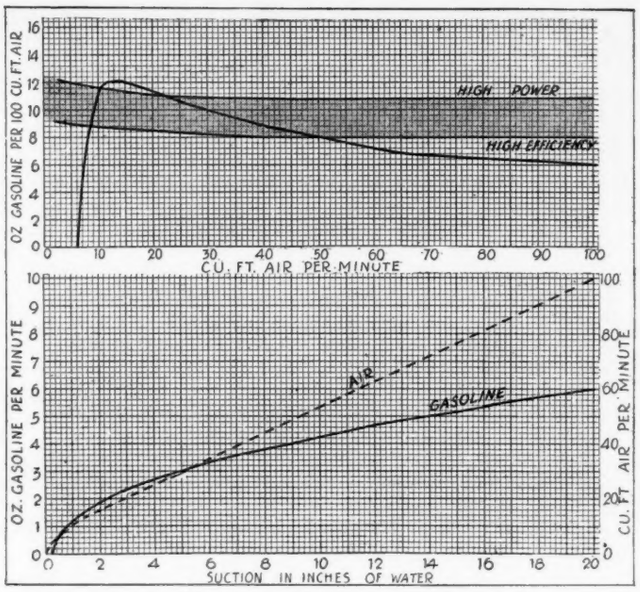
A third supply of gasoline is drawn from the atmospheric gravity well already referred to and discharged at a point on the motor side of the throttle. This is also essentially a constant quantity and its effect on the quality is indicated by the quality curve marked Throttle By-Pass in Fig. 3.

When the throttle is nearly closed the by-pass comes into action and draws gasoline from the gravity well, but when the throttle is wide open and the motor is slowed down by additional load the decreasing suction of the motor permits the atmospheric well to gradually fill with gasoline, thus decreasing the gravity head in the float chamber and causing the quantity discharged into the well to decrease. The effect of this smaller quantity of gasoline drawn from the atmospheric well is shown in Fig. 3 on that part of the quality curve marked Wide Open Throttle. The other branch marked Partly Open Throttle in Fig. 3 indicates the quality when, by progressively closing the throttle, the by-pass comes into action and prevents the level in the atmospheric well from rising. The quantities which produce the branches of the quality curve Main and Compensating Jets, are shown in Fig. 4 by the branches of the quantity curve.

With this arrangement then the carbureter has two distinct quality curves as shown by full lines.



Above—Fig. 3, Below—Fig. 4—Curves for carbureter with fixed orifices and compensating device



Above—Fig. 5, Below—Fig. 6—Analysis of mixture produced by elemental type air valve carbureter

This completes the analysis of this class of carbureters. It is a small class and no further types will be considered.

Air Valve Carbureters

This class of carbureters is much larger than all other classes combined, and the class is represented by a large number of types. Only a few of the most important types will here be considered.

The air valve carbureter will be best understood by first making an analysis of the simplest form, in which all the gasoline is admitted through a fixed orifice and all the air through an air valve closed by a spring.

This is an imaginary type which could not be used with success in practice.

Referring to Fig. 5, it will be seen that the quality does not follow the desirable zone, but crosses it at an angle, thus making a very limited range of capacity through which the mixture would fire.

The analysis of this quality diagram will be found in Fig. 6.

Comparing the quality diagram of Fig. 5 with the diagram of Fig. 2, it is evident that a combination of the two systems of control would make a better quality diagram than either.

This suggests the type of air valve carbureter that will be next considered.

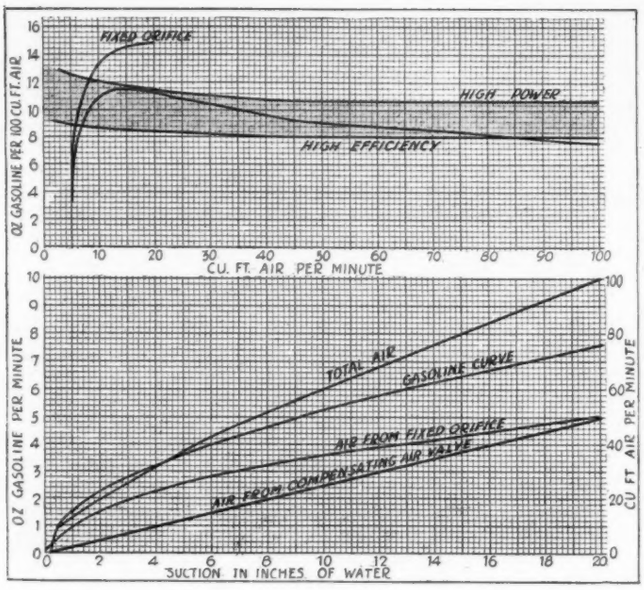
A Simple Carbureter

A carbureter with compensating air valve and fixed orifice is well known in a great variety of forms. The fixed air orifice is often called the strangle tube, or the venturi choke, and ordinarily the gasoline nozzle terminates in this passage. It will be assumed in this case as in the preceding cases, that the gasoline is regulated by a fixed orifice, or, in other words, that the area of the gasoline orifice remains unchanged in the operation of the carbureter.

A second air passage in this type is closed by a spring opposed air valve, which opens as the suction increases.

Referring to Fig. 7, the three dotted curves represent quantities of air passing through the air passages with different degrees of vacuum in the manifold as indicated by the scale at the bottom of the chart.

The lower dotted curve indicates the quantities admitted by the progressively opening air valve. The next dotted line represents the quantities admitted through the fixed air orifice and the third dotted line is the sum of these quantities



Below—Fig. 7, Above—Fig. 8—Carbureter with compensating air valve device

and is therefore the total air. The full line curve indicates the quantities of gasoline admitted through the fixed gasoline orifice.

Referring to Fig. 8, the dotted curve shows what the quality would have been if the air valve had been prevented from opening, and the full line curve indicates the quality when the air valve is free to open in response to increasing suction.

Supplemental Gasoline Jet

Various means have been used to cause a second gasoline jet to come into action before reaching maximum capacity, thus augmenting the supply where it has become deficient.

If this second jet comes into service abruptly as it does in many cases, it causes the quality diagram to make abrupt changes of quality.

This is clearly shown in Fig. 9, which is a diagram actually made by a well-known carbureter of this type. The dotted curve shows what the quality would have been with the first jet only, and the added richness caused by the second jet is shown by the full line curve.

Metering Pin on Air Valve

Fig. 10, shows how the effect sought to be produced with the double jet as shown by Fig. 9, is more perfectly produced by a tapering metering pin attached to the air valve and arranged so that when the aid orifice is increased by opening the air valve, the gasoline orifice is simultaneously increased by withdrawing the tapering pin.

With this device a fluid dashpot attached to the valve seems to be necessary to prevent objectionable reciprocating motion of the metering pin attached to the air valve. These moving parts attached to the air valve prevent a delicacy of action that is desirable when small quantities are being used and the forces acting on the valve are consequently very weak.

To overcome this difficulty and give stability of action it has been found necessary to make the primary fixed air orifice larger than with the simple carbureter, thus making it possible to keep the air valve in contact with the seat until the actuating forces have become of some magnitude. The effect of this is to make it impossible to enrich a small quantity of air. This will be seen by referring to Fig. 10. Under these conditions the closing of the throttle for slow speed reduces the motor speed partly by reducing the quantity of mixture entering the cylinder and partly by the decreasing richness of the mixture. This results in an extremely lean mixture for idling, and slow running, which fires with uncertainty and is very susceptible to the cold.

Throttle Cam Needle Valve

Fig 11 shows a quality diagram made by the best known carbureter of this type and it illustrates the effect produced by this method of control.

It will be seen that each of the several quality curves have the same general characteristic as the curve in Fig. 12.

These several curves in Fig. 11 show that in each case the needle valve remained in one position throughout the curve, which would necessarily mean that the throttle valve also remained in one position and the speed was changed by changing the load.

If the load at each speed is such that the necessary position of the throttle causes the needle valve to supply the amount of fuel required by the air that is being used, then a normal quality of mixture is supplied, but under all other conditions the mixture is either too lean or too rich. To understand this clearly, refer to Fig. 11, and note that when 100 ft. of air was being used by the motor, the quality of the mixture was 10.

Assuming now that the throttle remains wide open, and the speed is reduced by increasing the load (as it would be in climbing a hill) the quality grows steadily richer following the upper curve and the motor presently ceases to fire because of excessive richness. This is a condition that is always found the gasoline orifice is varied by opening and closing the throttle.

Liquid Friction as a Factor

In the analysis of all the types of carbureters that have been considered, the quantities of gasoline flowing through a fixed orifice have been assumed to vary as the square root of the suction or head. The curve representing these quantities is also the curve representing the velocity of a mass in equal increments of time when acted on by a constant

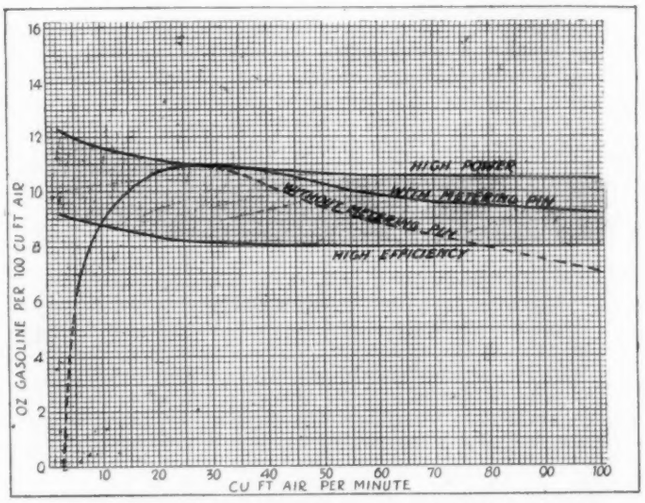


Fig. 10—Carbureter with metering pin attached to air valve

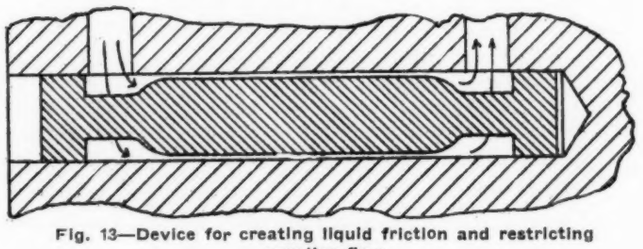


Fig. 13—Device for creating liquid friction and restricting gasoline flow

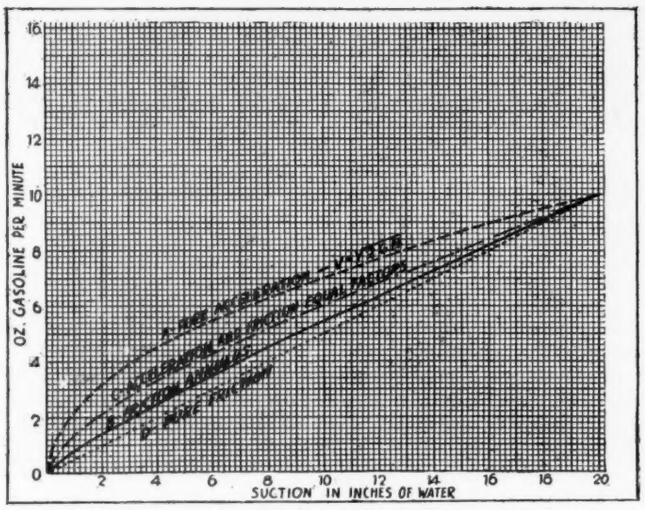


Fig. 14—Curves showing effect of liquid friction attachment

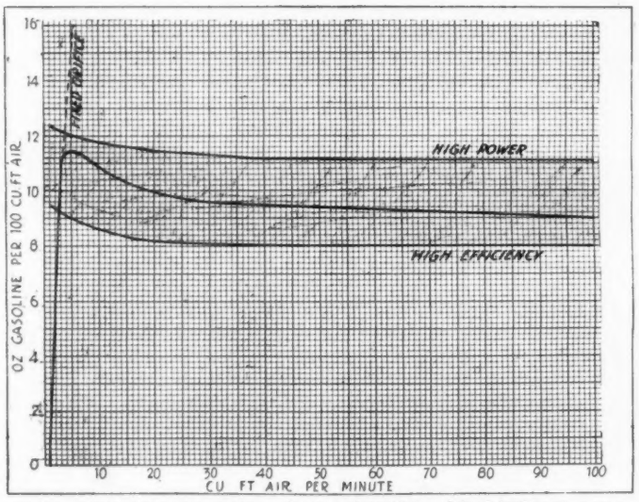


Fig. 16—Curve from air valve carbureter with frictional gasoline damper

force as the force of gravitation, and the law is called the law of acceleration. Because of the foregoing, it is evident that the friction of liquid flowing through an orifice is a negligible quantity, and that the inertia of the liquid which opposes acceleration through the orifice is practically the only factor, and the flow may be called an acceleration flow.

Liquid friction, however, may be so magnified relatively to the inertia of the liquid as to become the dominating factor, in which case the shape of the curve is greatly changed because the resistance of friction is directly as the velocity and not as the square of the velocity.

Fig. 13, represents a device for magnifying liquid friction relatively to the resistance of its inertia. It will be seen that the liquid passes through a very thin annulus of relatively large diameter. This thin liquid tube encounters liquid friction on a large surface, both inside and outside. Because of the high degree of friction thus developed, the cross section area of the annulus must be much larger for a given quantity than would be required with an orifice flow, and this decreases the velocity and consequently the effect of inertia.

The rounded corners of the entrance to the annulus eliminates a resistance called entrance head. Fig. 14, is a graphical illustration of the foregoing. The curve *A* will be recognized as the curve representing the relative quantities discharged by an orifice. The diagonal line connecting the ends of curve *A* represents the quantities that would be discharged if the only resistance to the flow were friction, because in that case the quantities would increase directly as the head. This, of course, is an impossible condition in practice. Curve *B* represents the quantities actually discharged when the flow was resisted by a device such as is shown in Fig. 13.

The dotted curve *C* passes midway between the curve *A* and the diagonal line. All curves between *A* and *C* may be called curves of acceleration flow, because in every case acceleration is the dominating factor, and curves between *C* and the straight line may be called curves of friction flow, because in every case friction is the dominating factor.

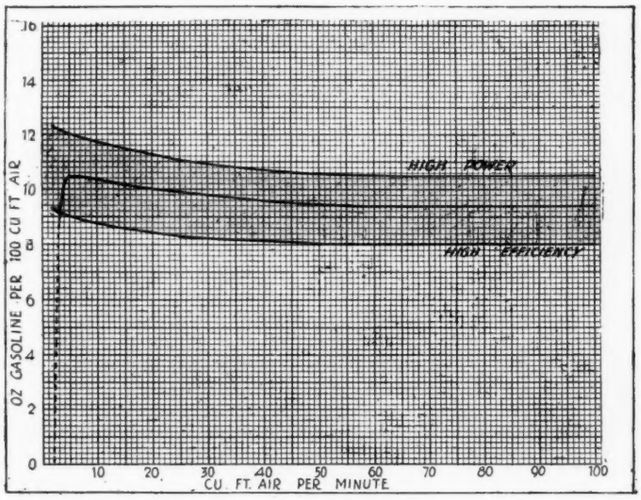
Friction Control of Gasoline

Referring to Figs. 5 and 6, it will be noticed that the reason a constant ratio between the gasoline and air cannot be maintained is that the quantities of gasoline discharged by a fixed orifice are found along a curve and the quantities of air discharged by a spring opposed air valve are found along a straight line, or practically so, and a straight line cannot be made to coincide with a curve except at a single point.

Referring now to Fig. 15, it is evident that a gasoline flow represented by curve *B* is much more desirable to use with an air curve represented by a straight line than the gasoline curve *A*.

In Fig. 15, will be found the analysis of a carbureter using friction control of gasoline. This analysis follows the same general plan that was followed on the preceding pages, and the resulting quality diagram will be found in Fig. 16.

(To be continued)



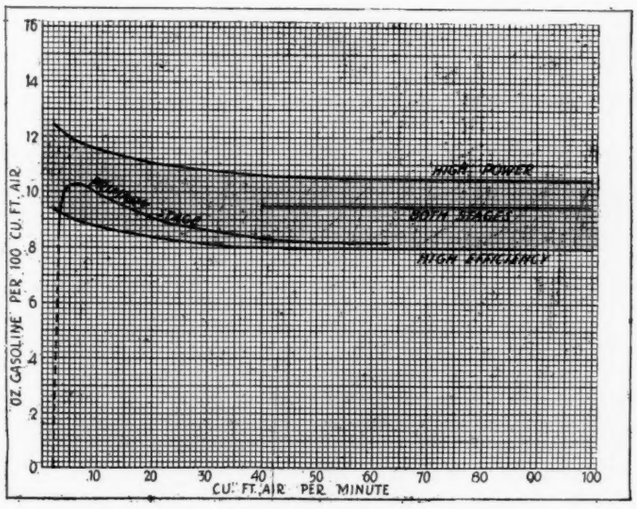


Fig. 18—Air valve carbureter with friction device taken from actual carbureter

Fig. 19—Curves of actual two-stage carbureter

Springs without Shackles Possible

Some Experiments Being Made With Different Designs—A New System for Spring Leaf Lubrication

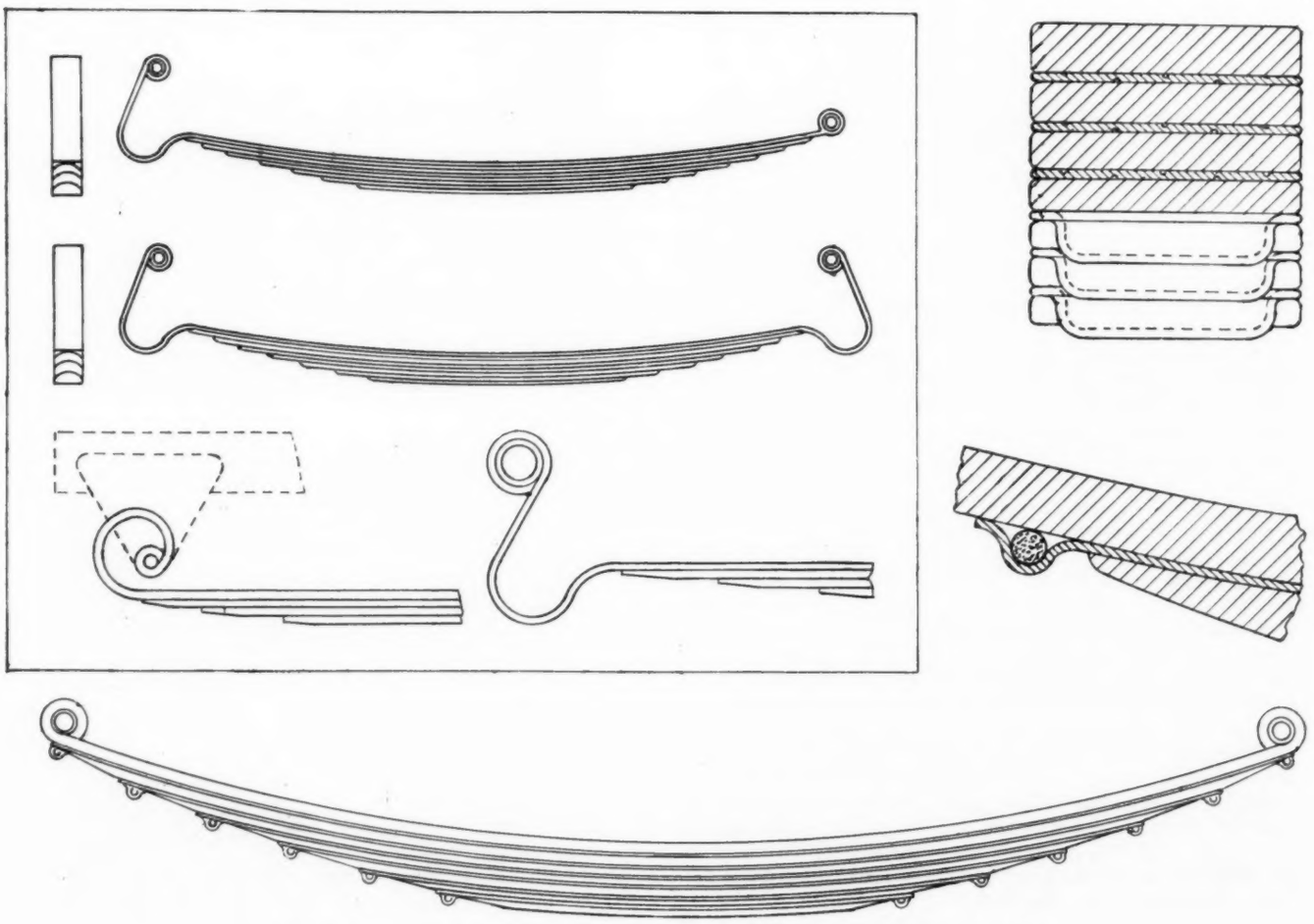
RECOGNIZING that the part of the spring suspension which is the quickest to show wear is the spring shackle, the Sheldon Axle & Spring Co. have been making experiments with several designs of spring in which the shackle is eliminated altogether. The amount of movement on a shackle pin is extremely small, which is the reason why these pins are so difficult to lubricate properly. Since the purpose of the shackle is to allow for the very slight variations in length of a flat spring as it is flexed, the substitution of a secondary spring action to replace the shackle is a natural step, and the Sheldon design consists of a slight alteration to the form of the main spring so that it can compensate for changes in length within itself.

The sketches show several different ways of working out the idea, and the experiments so far are promising in their results. It must be explained, however, that these springs are not yet being used commercially since it is desired to try out the different shapes thoroughly.

The upper spring in the left group is designed for the rear position where Hotchkiss drive is used; the one immediately beneath is for use with a torque tube design where the spring needs to be free both ends, and the two scrolls at the bottom are alternative designs which are being tried out for durability, side by side.

A Lubricating Idea

The large spring at the bottom of the cut, and the two sections on the right side show an idea of A. M. Laycock's for lubricating spring leaves. Between each leaf pair is a piece of thin steel with grooves cut or pressed in it. These spacing strips are extended beyond the ends of the leaves and then rolled into little channels with the ends turned up, and the cup so formed is filled with an absorbent pad. The channel has a hole pierced in one end, the spring being so mounted that this end comes on the outside of the chassis, and it is only a short task to inject a squirt of oil into each cup.



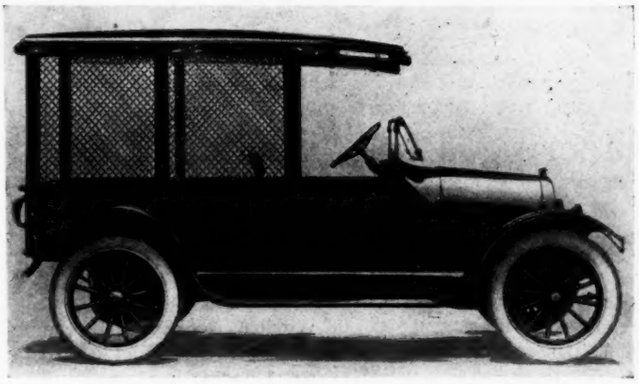
Top Left—Group of scroll end springs designed for use without shackles.
Below and Right—Idea for lubricating spring leaves with an oil can.

Overland Adds Light Delivery Model

A NEW delivery car known as model 75 has been brought out by the Willys-Overland Co., Toledo, Ohio. The new car is smaller than the previous Overland delivery vehicle, which had 800 lb. capacity and sold for $695. The new car sells for $595 and has a capacity of 750 lb. It is furnished complete with a screen-sided body and is intended particularly for light fast delivery work. It is mounted on pneumatic tires and is provided with side doors on the cab and complete electrical equipment.

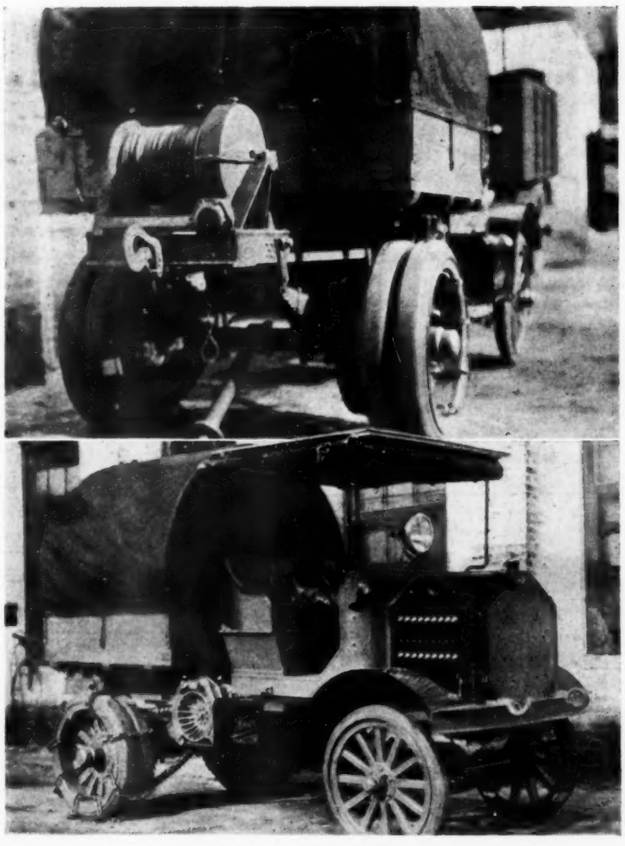
The new motor differs from that employed previously on the Overland commercial wagon. The cylinders are cast in block and the valves are to the right instead of to the left. The previous engine had individual cylinders. Cooling is by thermo-syphon and ignition by the single Splitdorf instrument with hand advance.

It has a cone clutch, connected with the gearset by a torsion tube inclosing the driveshaft, the gearbox being mounted on the rear axle as in previous Overland models. Torque and propulsive stresses are both taken through the torsion tube. Rear springs are of the cantilever type, three-quarters-elliptic springs being used on the larger model. The steering wheel is to the left and the levers are in the center. The tires are mounted on demountable rims. The standard body is of the piano box type, extending back on a line with the top edge of the cab door and surmounted by a stage top on six uprights. Roller curtains are provided in addition to the screen sides and a tailboard is fitted at the rear with leather retaining straps. The driver's seat extends part way into the body and, unlike the helper's seat, has a folding back to afford access to the load from the front. The helper's seat folds out of the way when not in use.



The new Overland light delivery car selling at $595

A New Knox Towing Winch Tractor



Two views of the new Knox towing winch tractor, showing its compact construction. The mounting of the towing winch horizontally across the rear is illustrated above

A NEW towing winch tractor has been placed on the market by the Knox Motor Associates, Springfield, Mass., under the name of model 36. The new machine is a self-contained vehicle practically identical with the model 35 semi-tractor, except that the frame is carried well back of the rear axle and it is mounted on a single set of semi-elliptics instead of the two sets of springs, semi-elliptic and cantilever, used on the older model. The body, which is about 4-ft. long and of about the same width, is placed immediately behind the cab, the winch being placed horizontally across the frame behind it. It is equipped with towing hooks fore and aft, the rear being centrally located and the front consisting of two mounted on each forward corner.

Triangular brackets of substantial section are used for the winch mounting and the drive is by worm from a transverse shaft driven off the gearset. The winch is controlled by a separate clutch. It carries 150 ft. of wire cable, and at 1000 r.p.m. the motor hauls in the cable at 150 ft. per minute. There is a large sprag to anchor the tractor when the winch is in operation. This can be lifted readily when not in use and is pivoted directly to the rear axle to allow the cushioning effect of the springs to come into effect when it is in use.

A heavy coil buffer spring is used in connection with the rear towing hook to cushion the draft. The capacity of the chassis is 4 tons, the body permitting a traction-giving load to be carried and also providing carrying space for road tools, etc., if desired.

Among the uses of the winch may be mentioned wrecking purposes, heavy hoisting, emergency hauling and all-around utility work in pulling through bad stretches of road, etc. The pulling-power of the winch is 20,000 lb. For traction on roads not adapted to rubber tires steel wheels are provided at slightly extra cost. These are interchangeable with the rubber-shod wooden wheels. The hydraulic brake used on the older model tractor is also employed on this. The price of the vehicle is $5,000.

The FORVM

WHEEL WOBBLE CAUSED BY STEERING LINK LAYOUT—THROTTLING BY CHANGING LIFT OF INTAKE VALVE—KEROSENE TROUBLES IN USING GASOLINE—BRAKE-ACTUATING SYSTEM AND REBOUND CHECKS

Steering Link Design Causes Wheel Wobble

By Leon A. Chaminade

THE articles on steering gear layout published in THE AUTOMOBILE for March 23 and April 6, by H. H. Dyke and Theo. D. Stanley respectively, have brought to my attention a correction for the faults of the present steering system, which has not been, to my knowledge, brought forth in the trade papers. Having had many years' experience as a driver of automobiles and being at present a student of machine design, I heartily agree with Mr. Dyke about the advantages of the present arrangements of the front spring, steering link and knuckle steering arm, which cause a bad wobbling of the front wheels while traveling over rough roads.

Mr. Dyke is in error in saying that with any alternative construction, from the present standard arrangement of steering connection from frame to axle, the steering link must run crosswise or partly crosswise of the car. Fig. 1 shows a front spring pivoted at its rear end and shackled at its front end. The steering gear housing is attached to the top of the frame and the steering gear arm projects downward outside the frame, having its lower point on the center line of the front spring pivot pin when the wheels are parallel to the axis of the frame, that is, when the car is traveling in a straight line. Since the axle in its up and down motion travels along the arc *A*, which has its center at *A*, the steering knuckle arm will move along this same arc. In the present standard arrangement this true motion of the steering knuckle arm is interfered with as explained by Mr. Dyke, but with the construction shown in Fig. 1 there is no interference and therefore no wobbling of the front wheels because the front end of the steering link moves along the same arc, *A*, for the steering link and spring are pivoted on the same center line.

The advantages of this construction are that the spring will act as a cushioning buffer between the front axle and frame as in the standard arrangement; that the spring will prevent side sway or lateral movement of the front wheels relative to the frame; and will permit the cushioning movement between the front axle and frame to take place without interference with the proper action of the steering connection. The steering gear arm, and therefore the steering gear housing, will be placed further forward than in the standard arrangement, necessitating more rake to the steering column, which means a more comfortable position of the steering wheel for the driver. There will be much less wear on all steering gear parts. This construction does not bring the steering link crosswise of the car but parallel to it. The disadvantage is that the front axle is pushed by the spring and not pulled by it; but this disadvantage is far more theoretical than practical as shown by the best racing machines and a large percentage of the stock cars built today, on which not only the rear axle but the whole car is pushed by the rear spring. If the rear spring is capable of pushing the whole car satisfactorily why cannot the front spring push the front axle and wheels in a perfectly satisfactory manner?

Throttling by Changing Intake Valve Lift

By C. J. Morrison,
Chief Engineer, Meyer, Morrison & Co., Inc.

THE suggestion in a recent issue of THE AUTOMOBILE that throttling be accomplished by changing the lift of the intake valve is very interesting. It appears, for many reasons, to be a better way of throttling than present methods, but, unfortunately is hard to accomplish on motors having more than two cylinders.

The old one-cylinder Cadillacs used this method of throttling with great success. This motor, in common with other early types, was modeled after the steam engine, and the intake valve was actuated by means of an eccentric on a half time shaft just back of the crankshaft and a connecting-rod similar to the device used on steam engines. The back end of the rod ran on a roller which could be raised and lowered by means of a fulcrum connected to a rod which led to a handle on the steering column. When the fulcrum was in its lowest position, the connecting-rod simply ran back and forth on the roller without lifting the valve. As the fulcrum was raised, the rod opened the valve more and more until the full opening was reached. Of course the rod had considerable travel in order that the valve could seat after being lifted to its greatest opening.

The carbureter on this car was also interesting as its design was entirely different from present practice. Gasoline passed through a needle valve and dropped down onto a fine mesh wire screen which completely filled the air inlet. This screen was funnel shaped and had its point toward the in-

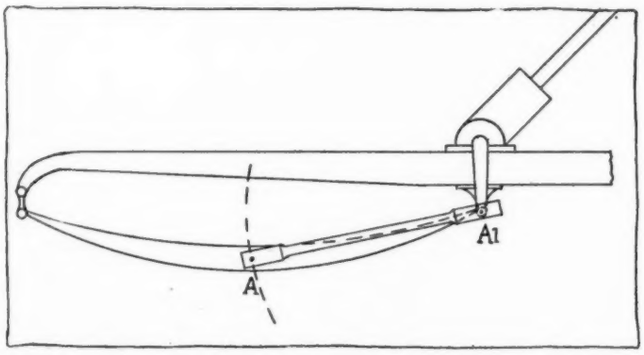


Fig. 1—Action of steering link when front spring is pivoted at its rear end and shackled at the front. This construction is designed to prevent the wheels from wobbling

coming air. As the air passed through the screen it picked up the gasoline vapor and formed a perfect mixture. The stem of the needle valve was attached to a flat circular disk which raised in response to the suction from the engine and permitted gasoline to fall down onto the screen.

This carbureter was not waterjacketed but was practically part of the cylinder head and therefore kept warm. The addition of a stove over the exhaust pipe would undoubtedly enable it to handle present day fuel very efficiently.

Excellent Vaporization

The method of vaporizing the gasoline and mixing with the air was better than in some of the latest designs. When a drop of gasoline fell on the screen it spread out in a thin film which insured that it would vaporize and mix thoroughly with the incoming air.

A few years ago a man who was still driving one of the old Cadillacs was asked what kind of a carbureter it had. He studied for a moment, then said, "Carbureter? What is that? I don't believe my car has one." Although he had driven the car for many years and had taken all the care of it himself, he had never had any reason for discovering the carbureter. There is a lesson in this for some of the designers of the modern car.

Kerosene Troubles Exist in Gasoline Carburetion

By W. P. Deppé

I WISH to call attention to a phase of carbureting so-called cracked gasolines which is beginning to become more apparent every day as the increase of kerosene cuts, perhaps, are being forced into gasolines, to answer the public's cry for more fuel all the time.

In the article on "The Problems of Kerosene," in THE AUTOMOBILE for March 30, quite ably written by A. L. Clayden, chairman of the standardization committee of the S. A. E., he calls attention to some well-known features of difficulty surrounding the use of kerosene in high speed variable speed engines, as compared to the use of gasolines in the same engines.

But he did not mention the fact that kerosene troubles are actually existing to-day in the average gasoline carburetion on practically all automobiles now outstanding with the ordinary designs of carbureters, as they are now generally known. It is the cause of loss of power, difficult starting at times in cold engines, less miles per gallon, even in the smaller engines, and lighter cars, in some sections, with resultant fewer ton miles per gallon of fuel consumed than ever before. This is apparent when one takes the time and trouble to go into details of any average statistics bearing on this subject.

Properties Remain the Same

I refer to the fact that if you crack crudes or kerosenes, by any known method of distillation, into so-called gasolines, which may perhaps show higher Baumé scale readings, and lower boiling point temperatures when in liquid state as such cracked gasolines, in comparison to the same readings in the crudes or the heavier hydrocarbons from which they were cracked, that you do not as yet seem to alter the action of the vapors or gases, in carbureting for internal combustion engines with these so-called cracked gasolines. That is, the vapors and gases seem to require just as high temperatures and heat volumes to hold them in such states as the original oils required for their vapors and gases, when in motors, mixing chambers, manifolds, valve chambers, and within the cylinders during intake stroke, etc.

The vapors of so-called cracked gasolines, and their gases act just like those of kerosene mentioned by Mr. Clayden in the article mentioned, in transit in manifolds, seem just as susceptible to temperature variations due to throttling, expansion, precipitation from gas to vapor and then to liquids, and are just as slow to ignite and with flame propagation seemingly just as slow as the vapors and gases of the heavier hydrocarbons from which these so-called gasolines were cracked by any method I have seen demonstrated either in the laboratory or in the commercial sales of gasolines.

I am glad to say, however, that it is possible now for any automobile engineer to have carburetion methods installed in any good four-cylinder model, with proper designs used for gas producers, distributing manifolds, valve chambers, with correct relation between bore and stroke, and where the highest engine speeds do not require much over 2000 r.p.m. using either gasoline or kerosene.

Either Fuel Can Be Used

In such a unit, it is now possible to operate either on all gasoline, mixtures of gasoline with kerosenes, either mechanically after put into the markets, or through the cracking methods of making gasolines from heavier hydrocarbons, or on all kerosenes, when gas producers and other details are adjusted with heat sufficient to handle all kerosene. There is no perceptible difference in road work, with but very slight variations on brake load in the testing rooms, as between all gasolines, or all kerosenes, with heat sufficient to handle all kerosenes; all on the same fixed meter adjustments. There is a slight loss of power above 2000 r.p.m. and even some brake load losses in power over 1000 r.p.m., but these are not apparent on the road tests, because these gas producers on the road tests work as designed. That is, they average up the variables met with on the road, but some of which are fixed in dynamometer tests, and too much heat develops on the brake tests, in some respects, but which are leveled out in road work, as cars are used in ordinary daily routine.

There is no apparent difference in the throttling flexibility as between so-called gasolines of to-day and all kerosene, as such things are now furnished to the average user, because for the reason given above, there is really no difference in the action of vapors and gases of so-called cracked gasolines and all kerosenes, after being carbureted. The only thing one must guard against is to avoid fractional distillation or gas dissociation in carbureting with such high temperatures as are required in handling all kerosenes.

Thinks Four Is Ultimate Engine

In my opinion, from a purely gas production standpoint, I should say that the four-cylinder engine, L-head type, is the ultimate engine, because of the time elements, the actions of vapors and gases of present day oil fuels however distilled from crudes, or however vaporized or gasified, when carbureted. Because of the fact that as I understand it no two intake valves are open at once in a four, and there are two in a six, and more in engines with more than six cylinders, which bring about temperature drops, as outlined by Mr. Clayden in his article on kerosene carburetion. You cannot permit the splitting of the mixture charge to two cylinders at once, without setting up some of the disadvantages mentioned by Mr. Clayden in this article.

With gas producers furnishing a more or less dry gas rather than vapor mixtures at all times, even under the action of throttling, from the lightning-like governor throttle in four-cylinder, vertical tractor engines, to the more leisurely throttling complications from working through several miles of Fifth Avenue traffic at the time of greatest congestion, a four with the same crankshaft finish and balance, as has been developed in most good sixes, etc., will be just as velvety, with not as much vibration as with six or more cylinders, will have swifter getaway, better traction in snow, mud, sand, and on long hills, in the gasolines now coming into play,

which the gentlemen of the S. A. E. must plan to treat as kerosene vapors and gases must be handled, if there is to be that greater development of the internal combustion engine which the past development of that form of prime motive power would indicate is possible.

L-Head Feature Important

As one who knows little else but gas production from oils, I should say that it is not a question of mechanical merit, or refinement, as between engines with four cylinders, or more cylinders, but it is in fact a question of the engine which can be carbureted with the oils now here, and worse coming, and which must run in fact on kerosene vapors and gases, whether you feed them cracked gasolines, or all kerosene. Any man who has spent enough time on carbureting kerosenes and their gases and vapors to find out just how little he really knows about the oil fuels will certainly suggest that the fours from now on be given very careful consideration, and particularly the L-head type, because of the fact that the exhaust gases pass out next to the intake ports in that form of engine.

Brake-Actuating Mechanism and Rebound Checks

By Marius C. Krarup

IN the article by A. L. Clayden last week on brake action with the so-called Hotchkiss drive, through the rear springs as driving-struts, two things strike me as remarkable: It is perfectly clear and it offers a remedy. Furthermore, this remedy is applicable also in those cases where the fault is already remedied in part through the use of nearly straight springs and other provisions tending to equalize the distance from brake pedal to brake cam for all positions of the axle.

To illustrate how your article strikes through, I may mention a few of the ideas to which it seems to loan new strength. One lies close to the surface, relating to rebound checks. As you point out, if there is a dangerous discrepancy between the curve of the axle movement under shock action and the curve described by the end of the brake pull rod, this discrepancy will be most pronounced at the extremes of the movements, at the highest and at the lowest possible positions of the axle. The shorter the arcs can be made without interfering with the springing, the more accurately can they be made to correspond If the lower or rebound end of the arcs is cut out, a little can be added at the upper end, in favor of greater flexibility in the semi-elliptic leaf springs, and it seems to be generally admitted that greater flexibility is desirable in truck springs, if it can be managed. As brakes are particularly liable to be applied sharply immediately after a severe shock—even though a second earlier would have been better—and about simultaneously with the rebound, your article, it seems, demonstrates an advantage in properly designed rebound checks, in the matter of safeguarding the brake action, to which attention has not been called before.

Whether the equalizer shaft can always be located so as to have the action correct without introducing a new and additional element in the linkage, with corresponding accentuation of wear and frequent need of re-adjustment, or other complications, is perhaps another question, to be decided only by a careful examination of the layout in each case. At all events, an important point to which only the foremost designers have paid much attention in the past, has been brought clearly into the foreground for the information of all. All must now look to have the last section in the brake rod linkage act from the most suitable center, even if the drive is not taken through the springs.

From such material most practical progress has been forged. It comes not only through the direct adoption of the suggested remedy but also by shaping and strengthening the conception of other methods by which the shortcoming may be obviated. Thus the superficial idea, if it is correct and practical, really strikes toward the root of things with admirable efficiency—if you will permit me this bit of philosophic observation—reaching all who are interested in things as they are, and not only those pioneers whose mental chronometers show the time of day to a second while their ambitions are two to ten years ahead of the calendar.

Avoidance of Wear

A much more radical thought is suggested, however; radical in the sense of going to the root of things. It is understood that the greatest danger of failing brake action comes through the need of adjustment of the linkage. We should have an actuating mechanism that does not wear or is not affected by wear, so far as the brake action resulting from a given pedal movement is concerned.

Tracing the wear back to its source, we find that most of it is due to the resistance. During the act of turning the cam the progressive resistance of the cam is transmitted to every working joint. We should therefore have an operating mechanism that does not share in the work done by the brakes while they are being turned on. The cam is retroactive. But even if it were worked through an irreversible worm, the linkage would still support the work of tightening the brakes and the conception of a mechanism which works without any notable resistance is more attractive. The electric brake is in this class. The hydraulic brake can be designed on this plan. The compressed-air brake likewise. And it is not out of all question to have a mechanical friction brake so actuated, even if it is not of the centrifugal type which probably never can be resurrected. We can, for example, easily imagine a pin being pushed into a hydraulic device within the brake drum, to set certain valves and causing the device to be actuated with greater or lesser resistance according to the depth to which the pin is inserted, or causing the hydraulic device to operate, by means of the rotation of the wheel, ordinary brake shoes in the drum. I have no doubt that, in cars with electric equipment, electric brakes will be in use long after the pedal-shaft-crank-rod-crank-rod-equalizer-crank-rod-crank-shaft-cam-retractor-spring mechanism has gone to the discard. And with regard to the other types of brake which may be operated without notable resistance or wear in the actuating mechanism, the designing and perfecting of them probably only awaits the demand.

Your article will do a great deal, I should judge, to bring such a demand to a focus both among the public and the manufacturers, having laid before us so clearly the most radical shortcoming in the existing system.

I should like to dwell on the clear and unmistakable language in which your subject is set forth, as to my mind there is the most intimate relation between lucid diction and engineering progress, but, as your space is limited and the subject a separate one, even if it is suggested in this connection, I shall bring this up some other time.

One more word about rebound checks, however, as they were referred to above only as an aid in obtaining reliable brake action. Their chief mission is of course to secure comfort with flexible vehicle springs and protect the latter, but it may not be amiss to mention another purpose, which they always serve in some degree and could be made to serve more fully. I refer to their value for obviating the vibration of axles which are heavy at the middle and for which now an adjustable brace rod is commonly provided. This brace rod with its dangers of maladjustment and fractures could well be spared if suitable rebound checks were applied. Frequently two straps are used, each about midway between the differential housing and the wheel, but they are necessarily

adjusted to light load (so as not to make the springing hard for that condition) and protect neither the axle nor the springs sufficiently when severe shocks are received under full load. If, on the other hand, a more efficient rebound check were applied at the middle of the axle, such practice would be economical, and the axle vibration would be fully obviated. And, in the case of one-wheel shocks, probably as much checking effect for the rebound of the springs as is necessary can be obtained on this plan, provided the checking device is robust enough and of the required design. The requirements in this respect, at least for all trucks and omnibuses, are simply, it seems, that the rebound check shall have an action accommodating itself perfectly to load variations, so that the checking may always be entirely completed when the spring has returned, after a shock, to its original position of equilibrium under whatever static load it happens to carry at any given time—and not always to the same position. If there is not room for a practical development in this direction it would be interesting to know why not, and I take it that your Forum is the place for just such questions and their answers.

Differential Increases Difficulties for Dump Trucks

By L. G. Bartlett,
Chief Engineer, Old Reliable Motor Truck Co.

THE writer was very much interested in the article by A. Ludlow Clayden in last week's issue of THE AUTOMOBILE respecting the experiments which are being carried on by various engineers respecting the possibility of eliminating the differential from commercial vehicles, and gladly gives you his experience with heavy dump trucks, which had approximately 8½ tons paying load.

The chassis and body, with hoist complete, weighed 12,500 lb., and the wheelbase was 150 in., with dual 40 by 7-in. tires in rear and 36 by 6-in. singles in front, with chassis and body distribution of 55 per cent in rear, and 45 per cent in front, while the paying load distribution is approximately 85 per cent in rear, and 15 per cent in front. This load distribution may seem excessively heavy in rear, but the writer has checked a number of jobs where the distribution has shown an excess of 100 per cent, the overhang having been tolerated in order to provide the required dumping angle, and also eliminate body and hoist strains.

With the abovementioned loading conditions, and with the very short wheelbase which the American type of truck allows, we found that it was entirely impossible, with the differential locked, to make anything like the short turns which we had been able to accomplish, and moreover, were quite surprised to find that when the streets were sufficiently wet and slippery, to allow a differentiating action to take place, the result was that the much greater traction of the rear wheels would force the front wheels to proceed in direct line with them, regardless of the manipulation of the steering gear. This would invariably occur in alleys, or in places where there was considerable soft earth, or loose material, and was of decided disadvantage to the particular truck in question, because the short wheelbase made abrupt turning easily accomplished, and reduced running time very materially on short hauls, and in tight places. On slower turns, there was a decided increase in the power required, but steering was not seriously affected.

The writer is pleased at this time to extend to you his hearty congratulations on the original work, and open forum which your articles are making possible in THE AUTOMOBILE, and no doubt expresses the feelings of many, that you are keeping us in closer touch with one another's difficulties and achievements, and materially assisting in the production of more economical and serviceable transportation.

Troublesome Differential's Days Are Numbered

By E. C. Shumard,
Engineer, United States Motor Truck Co.

IN reference to A. L. Clayden's article on locked differential, the writer has given this proposition considerable thought for a number of years, and will soon be testing out a Sheldon worm axle without differential.

There have been devised numerous contrivances for the purpose of locking together an ordinary differential to be used when one drive wheel encounters a slippery place. As a rule, they have not been altogether successful, because of complication and the human equation. The writer has observed many times that such locks have been connected and after the truck had been freed from the slippery position, the lock had been completely forgotten, and truck had proceeded on its way. It was evident that if this could be done frequently without damage or without even knowing of the condition, the differential was not a necessity.

Without data from actual tests, the writer is of the opinion that greater damage is done to the tires by their contact with the road under accelerated speed after bouncing over an obstruction and causing the wheel to leave the ground than could occur from the necessary slipping in making turns with both drive wheels keyed to a single bar.

Further, the fact that one wheel must spin when it leaves the ground or comes in contact with a slippery spot, and nearly always is stopped, suddenly, throws severe strains on differential and other parts, as well as the tires.

It has been generally believed that more power will be required in making turns without the differential. However, this argument is questionable because the increase in gear ratio through the differential is considerable, and also calls for more power when making short turns.

The writer believes that the troublesome differential's days are numbered.

Trucks Do Not Need Differentials

By J. G. Paine,
Detroit Commercial Car Co.

WE note with interest the article relative to the elimination of the differential from trucks. We have not carried out any experiments along this line, but it has long been our opinion that this move is not only desirable but is practical as well. In theory it may not line up just as we would so desire, but in our judgment for truck use, especially the slower-moving trucks, the absence of the differential would never be noticed, even in turning the shortest radius, but there would be a very distinct advantage where a truck had one driving wheel in a hole with no bottom on one side and the solid pavement on the other.

The writer has seen this condition many times this spring.

We hope to see discussions on this subject from manufacturers who have actually made experiments.

Differential Will Be Simplified

By A. C. Wollensak,
Chief Engineer Sterling Motor Truck Co.

WE have read with interest the article by A. L. Clayden relating to elimination of the differential, and also the article by Mr. Laycock and the editorial.

We are sure that great strides will be made in this direction in the near future. We do not know whether the differential will be entirely eliminated, but we do believe that it will be considerably simplified.

The History of the American Automobile Industry—27

Further Petroleum Developments—Its Use for Medicinal Purposes—Drake's First Well in 1859—Petroleum Ignored and Wasted—Later It Begins to Influence Inventors

By David Beecroft

IN spite of repeated forcing of her bountiful petroleum upon a blind and unwilling generation, Mother Nature was unable to make a people who thought they were progressive accept the wealth she was so anxious to give. Occasionally, some man with more ambition than his neighbors would bottle a little of it and sell it for medicinal purposes at 50 cents per half pint or would send a few bottles to the coast cities, recommending it for everything from cattle cures to cancers, in the hope of introducing it and getting a market started. The total used in this way was but trifling, however. The oils needed by civilization were secured largely from the sperm whale and from the products of the farms. Yet, with this natural supply neglected, we find a considerable industry growing up in artificial oil extracted at considerable expense from certain coals and shales.

In 1846, an illuminating oil made from a coal secured in Albert County, New Brunswick, Canada, was put on the United States market. Camphene distilled from turpentine was used for lighting, although considered quite dangerous because of its easy inflammability.

In 1850, the making of paraffin oil from coal, peat and shales had grown to such an extent as to be considered a financial success and the next ten years showed a very considerable development of these artificial products. Even the paraffin candle was produced, although it could not have competed with the tallow candle had it not been a by-product. Some idea of the progress since that date is expressed by the fact that the Standard Oil Co.'s candle output a couple of years ago in this age of acetylene, electricity and gas was 300,000,000.

1859—Drake's First Well

The Moses who had vision enough to lead out of this period was E. L. Drake, who, in 1859, went from the East to Oil Creek and drilled the first well near Titusville, his object being to secure oil. This started the movement toward the now great petroleum industry and the manufacture of artificial oil from coal ceased in 1860. The names of the earlier products, however, remained with us and were largely applied to the later natural ones. The next ten years were largely development ones. Wells producing oil rapidly increased and many attempts to use the newly recognized product were made in many different lines. Lighting by kerosene lamps became quickly the common and accepted form and absorbed the major portion of the oil output. The gasolines were thrown away as being both useless and dangerous, while the heavier portions were used principally as lubricating oils and found a considerable market in spite of prejudice against the new thing and in favor of animal lubrication.

The Waste of Gasoline

A peculiar manifestation of this period was numerous attempts to make gas for illumination from the kerosene by the application of heat and by the use of complicated mechanical constructions, while the gasolines, ready and willing to convert themselves into gas by the mere mixing with air, were ignored and thrown away. The only explanation possible seems to be that the experimenters were working with the material at hand and did not know of the waste by-product. This condition of affairs is found so often and in so many lines that it would seem a wise government should establish a public information bureau to which an experimenter might apply for the facts of benefit to himself and humanity in general without any additional expense.

Gasoline Influences Inventors

With this development of the oil industry in 1860, we can now understand why the internal combustion engine began to attract attention and crowd its predecessors to the rear just as the air engine or combined air and steam engine or steam and smoke engine had been promising to crowd the original steam engine. Kerosene, being available in practically every market, was naturally the fuel used. The internal combustion engine had been pretty well made known to the American public by Dr. Alfred Drake of Philadelphia, who, beginning his experiments in 1837, had exhibited his engine with hot-tube ignition at the Crystal Palace, New York, in 1855, which engine is said to have been "precisely like Lenoir's, which was brought out in Paris in 1860-2 and often claimed to be the first of this type. Ericsson's hot-air experiments on a large scale propelling an ocean-going steamer

and his exploitation of same had done much to direct public attention toward air and gas engines. Five air engine patents were granted to him between 1851 and 1860 and about forty hot-air engine patents were issued in the next twelve years, a very large number when the total patent issue is considered. George B. Brayton was building air and gas engines in 1864 and it is believed had taken up the work as early as 1857, although his first patent seems not to have been issued until 1872.

A Bubbling Type Carbureter

The patents of that period show a bubbling type carbureter by Ashcroft in which a float rested on the surface of the liquid while air admitted below the float followed a scroll or a spiral passage in the bottom of the float for a considerable length and so had much time to be saturated with the vapor of the liquid. This device was used by De Dion and other foreign makers thirty-five years later. A patent to Richardson & Pond in 1867 shows air sprayed in fine streams into and rising through the liquid for the same purpose.

That the gas engines of those days were troubled with carbon, was undoubtedly truer than to-day when carbureters are better, and Wiegand in 1864 mentions in his patent a liquid put into the cylinder, "to carry off the carbon" and improve the ignition. American publications described in 1865 the engine of Hugon as an improvement on the Lenoir and a method of obtaining an inflammable vapor by passing air through naphtha, petroleum or other volatile liquids invented by Wenham, both the above being foreigners. Lenoir cards were published in the *Scientific American* in 1866 and in the same year benzine vapor was suggested for the "newly introduced gas engines."

The next year, 1867, there appeared several articles on the use for petroleum for fuel and the activity in this line is indicated by the term mania.

In 1869 Maxim and Radley patented a carbureter in which the air was passed through heating and vaporizing chambers, this being the H. S. Maxim, who afterward built the light and powerful aeronautic engines which were so interesting to the earlier automobile workers.

In 1870 we find liquid fuel advocated for steam engines and petroleum gas from their own well, probably natural gas, in use at the Erie Water Works.

In 1873 Sloper patented a portable gas machine which was fitted with concentric partitions packed with picked cotton and excelsior through which the air could be drawn and absorb the vapor from these wick-like substances which rested in the petroleum liquid.

With these mentions, it seems unnecessary to consider further development of the use of petroleum in its relation to the automobile. The Brayton engines which rapidly assumed a commanding position, beginning with the early seventies, introduced the liquid fuel by pumps. The Otto engines, which in the middle eighties began crowding the Brayton from its position, mostly used city gas but where a carbureter was needed, it was of the surface or Sloper type, and this was the kind seen in use by Charles E. Duryea in 1886 when he selected the gasoline engine with its portable gas producer and electric ignition as containing the elements of the successful motor vehicle motor.

Elwood Haynes used, at first, a pump to introduce the liquid fuel and later, a mixing valve which admitted both air and liquid in approximately proper proportions. Duryea, however, never used the gas tank lest fire result and because a fear and criticism of this result would certainly exist, but in his very first machine, begun in 1891, developed a spray device. This was not wholly new with him, however, having been shown in a British patent of 1874 and being simply a modification of the well-known atomizer used for perfumes.

Gasoline at 5 Cents Per Gal.

The production and development of the petroleum industry, although in starting proceeded rather faster than the demands for the product so that the last years of the century found Duryea buying 5 gal. of high-grade gasoline at the corner grocery store in Peoria, Ill., hundreds of miles from an oil well, for an insignificant 25 cents. Kerosene at 3 to 4 cents per gallon in barrel lots delivered was so cheap that he refused to shovel coal and ashes but patented and used a kerosene burning furnace for heating his house. In more recent years the condition has reversed. Gasoline, once thrown away, is now the leader, the demand for kerosene has greatly diminished proportionately, while lubricating oil, particularly of high fire test for superheated steam and for gas engines, has become so necessary that these improved devices could hardly operate without it. So rapidly did these changes take place in the first dozen years of the present century that an old and experienced oil man refused to invest any money whatever in a truck propelled by gasoline because he was certain that gasoline prices would be prohibitive before he could get the truck on the market in paying quantity. The development of new fields greatly relieved the gasoline demand, but the condition would have been critical before this had not a process or processes been discovered for re-assembling the hydrogen and carbon constituents of petroleum so that the heavier grades may now be separated into lighter with a residue of still heavier ones.

Bulletin on Nickel Steels

WASHINGTON, D. C., April 22—The Bureau of Standards Department of Commerce, proposes to issue a series of circulars of information on the properties of the more interesting or technically important metals and alloys. The first of the series, describing the properties of the non-expansible alloy Invar and other nickel steels, has just been published. The magnetic, electrical, thermal and mechanical properties are given with numerous illustrations, together with statements concerning microstructure, constitution, applications, and sources of supply.

The publication is circular No. 58, entitled Invar and Related Nickel Steels, and copies will be sent free to interested persons upon application.

The Rostrum

Pinion Is Meshed Too Tightly

EDITOR THE AUTOMOBILE:—From the rear axle of my Saxon B roadster, 1915, there comes at low speeds a singing, humming noise which seems more pronounced at lower speeds, but at about 25 m.p.h. it is more or less lost in the other noises. I have packed the universal, the transmission and the rear axle pinion gears, but this has not seemed to have made any difference. The car has but lately come into my possession, so I do not know how long this condition was in developing. Could the small pinion be meshed deeper into the ring gear to overcome this, and if so, what will be the steps necessary? In this model how is this done? Could the gears already be too closely meshed? How can I tell when the adjustment is about correct? The rear wheel has vertical play of about 3/32 in. The right wheel is without play. In this excessive? Could this cause the noise?

Oil leaks out of the valve so that this side of the engine is covered with oil which drips on the mud pan, which in this car supports the engine. Would packing the valve cover plate with felt stop this or do I require new valve guides?

Summit, N. J. H. B. R.

—The pinions can be adjusted by removing the large pipe plug on the top of the transmission case and loosening the set screw on the side of the case. The adjusting nut is then turned in or out. In this case it is believed that the pinion is meshed too tightly with the ring gear, and it should be backed out six or eight notches.

The vertical play in the rear wheel is no doubt caused by worn bearing or axle shaft and to eliminate it it will be necessary to install new parts in place of the worn ones. The vertical play in the wheels would not cause the noise in the axle.

To stop the leak around the valve tappet cover it is only necessary to install new felt washers around the cover.

Correct Temperature for Vulcanization

Editor THE AUTOMOBILE:—What is the right heat a tire should have in order to vulcanize and how long should it be kept to said heat?

Fall River, Mass. J. H.

—This depends whether it is the inner tube or outer tube you are vulcanizing as far as time is concerned. Generally about 15 min. suffices to make an inner tube vulcanization at a temperature of about 145 deg. C. The tire shoe takes a longer time depending on the depth of vulcanization. It would be best to simply follow the directions with your vulcanizing outfit for practical results as this has been worked out to give proper temperatures for the conditions for which it is designed.

Wants More Quality in Cars

Editor THE AUTOMOBILE:—It is about two years now since a craze started for the production of "quantity" cars, in the sense that every American manufacturer seems to be striving to give a big car for little money.

There must be a large number of agents and dealers to whom this trend is unsatisfactory. An overwhelming number of our prospects are men not in a position to afford the enormously increased maintenance ratio consequent upon the use of a car with a long wheelbase having, necessarily, larger tires and increased weight. We point out that a 30 by 3½ tire sells, out here, for $25, a 34 by 4 for $35. Gasoline retails at never less than 60 cents per gallon and oil $1.40. Therefore the one desideratum is economical running cost.

Only the short-wheelbase, light car can give us this and instead of a 112-in. wheelbase, 2500 lb. car retailing, in America, at $750, we need a car of but 102 to 104 in. wheelbase weighing not more than 1750 lb. The selling price of $750 is about right, and as against the greater quantity we could be given more quality.

Trusting that it will not take up too much of your space, below we give a few abridged specifications which we think needful:

Wheelbase	102 in.
Track	56 in.
Tires	30 x 3½
Weight	1750 lb. or less
Cooling	thermo-syphon, large water capacity.
Motor	long-stroke, high-speed type 25 hp.
Carbureter	Zenith or similar type.
Gasoline tank	in dash.
Body	all metal; enamelled; very low streamline.
Speeds	three forward, one reverse
Seats	tilting downwards to rear.

Such a car, if put on the market by one of the big manufacturers, would command an instant clientèle.

For two years we have carefully scanned all your announcements giving details of any new models likely to suit us, until we came to the item wheelbase, our interest then ceasing, for it is invariably given as 110 in. or more.

The Studebaker Corp. put the just right car on the market during 1913, and withdrew it the following year. Why?

We have seen nothing in use of late that will compare with that little car for quality of material and equipment.

A similar size car is needed, but with altered body lines, etc., conforming to more modern ideas.

Beaufort, West, So. Af. J. W. COURTIS, Motor Supply Co.

Storage Battery for Dual Ignition

Editor THE AUTOMOBILE:—Why do we use battery with dual system magneto?

2—Why is spark advanced when cranking on the magneto?

3—Why should a magneto armature run at engine speed on four-cycle, four-cylinder engines?

4—Where is set ignition placed and on what system is it used?

Columbus, Ohio. L. L. S.

—The accompanying diagram, Fig. 2, illustrates the necessity for a storage battery to carry out the scheme of dual ignition. If there were no storage battery you would not have dual ignition, but single instead. Dual ignition employs two sources of current with one set of spark plugs. Hence the battery and the magneto.

2—Spark is advanced to take care of mechanical and electrical lag and to make the explosion occur as nearly as possible to upper dead center. In cranking, if the spark occurs at the point of highest compression ignition is much more certain.

3—The magneto produces two sparks to the revolution and since a four-cylinder, four-cycle engine has two explosions to a revolution it is necessary, in order to have the two sparks, to have the magneto operating at engine speed.

4—Set ignition can be used on any system desired. It simply means that the spark cannot be manually advanced. Generally the spark is set in relation to the speed of the motor so that the explosion will occur as near upper dead center as possible. See Fig. 1.

Noise Probably in Timing Gears

Editor THE AUTOMOBILE:—Since equipping my Stoddard-Dayton 48 with patent piston rings, the motor makes a loud humming and grating noise. The oiling system seems to be working all right. What is the cause of this and what should be done in this case?

Madisonville, Ky. F. D. C.

—It does not seem possible that piston rings can give a humming or grating noise. The indication of a ring which is too tight in the groove is a clicking sound, and it is suggested that you look after your timing gears, etc.

Connecting Accessories on McLaughlin-Buick

Editor THE AUTOMOBILE:—How would I correctly add an automatic cigar lighter made by the Electric Automatic Cigar Lighter Co., New York, and a self-winding clock made by the Hartford Clock Co., to a model D45 McLaughlin-Buick six-cylinder car; also an attachment for a trouble lamp?

Brandon, Man. W. M. C.

—The trouble lamp connection which fits in the instrument lamp socket is already furnished with these cars as a part of their regular equipment. Other devices such as the cigar lighter and the electric clock should be connected to No. 1, 2 or 3 switch terminal, but No. 3 terminal would probably be found to be most convenient. It will also be necessary to provide a ground connection for this lamp.

Information on Model 10 Buick

Editor THE AUTOMOBILE:—What is the fastest time a Buick 10 ever made?

2—What ratio did it have between motor and wheels?

3—What kind of magneto and carbureter?

4—What speed has a stock Buick 10 in good condition?

5—Will I have to get a complete new axle or new pinion and ring gear in order to gear a Buick 10 up?

6—About what will be the cost of same?

7—What is the ordinary ratio for this car?

8—What is the speed of the 1909 or 1910 Simplex, chain-driven, 50 hp.; National 40; Stutz bearcat; Mercer raceabout?

9—How, and to what limit can I speed up a Buick 10?

Norfolk, Va. R. M. P.

—The fastest time ever made by a Buick 10 car is unknown, as there are no official records on this model.

2—The model tens were geared 3 and 3½ to 1 with 32-in. wheels.

3—They were equipped with Remy magnetos and Schebler carbureters.

4—Between 50 and 60 m.p.h.

5—The gear ratio can be changed by inserting new pinion and ring gear only. Any Buick dealer or branch will be able to quote you prices for this material.

6—Given in question 5.

7—This is given in answer No. 2, which is printed above.

8—All the cars you mention when tuned up are good for about 75 m.p.h.

9—About 60 m.p.h.

Friction of Tire on Road

Editor THE AUTOMOBILE:—I am desirous of obtaining certain information relating to the tractive effort or rolling friction co-efficient of solid rubber tires on various road surfaces. That is, what relations exist between tractive effort in pounds at the rim of the driving wheel of a motor truck or other motor vehicle, total load on the wheels, speed of the truck and power of the engine or motor when operating over the various good and bad conditions of streets and roads.

This information is to be used for the theoretical calculation of the power required to drive certain capacity trucks over or through various road conditions at given speeds, employing solid rubber tires.

Columbus, Ohio. L. R. YEAGER.

—The following are the accepted figures for co-efficients of road friction for solid rubber tires of the usual compound:

Hard, level asphalt	0.0100
Wood pavement	0.0115
Level macadam	0.0115 to 0.0300
Plank road	0.0090
Cobble stones	0.0175
Good dirt road	0.0110 to 0.0200
Ordinary dirt country road	0.0200
Sand	0.2000

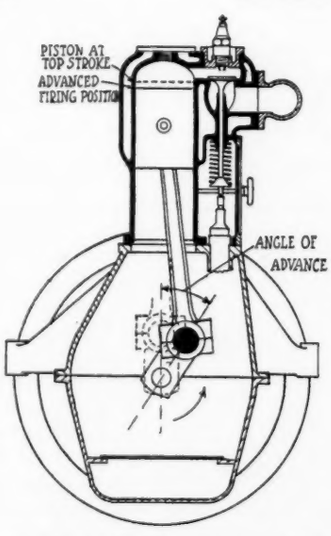
The tractive resistance of average roads against solid rubber tires is generally assumed to be 60 lb. per ton of weight on the wheel. Speed and motor power do not materially affect these figures excepting that there is a certain percentage of slip at high speeds and that too sudden application of power will of course prevent the tires taking hold.

Tire Sizes and Speedometer Gears

Editor THE AUTOMOBILE:—I am using a 37 by 5 tire on a 36 by 4½ rim but did not change the speedometer gears which are for the 36 by 4½ tire. What amount in speed and mileage is my speedometer registering wrong if anything at all? I think my speedometer is registering too slow but would like to know how much.

Allentown, Pa. H. J. G.

—The mileage will err to the amount of 3.1416 in. every revolution of the car wheel. The reading on the speedometer will indicate too little by that amount. At 10 m.p.h. a 37-in.



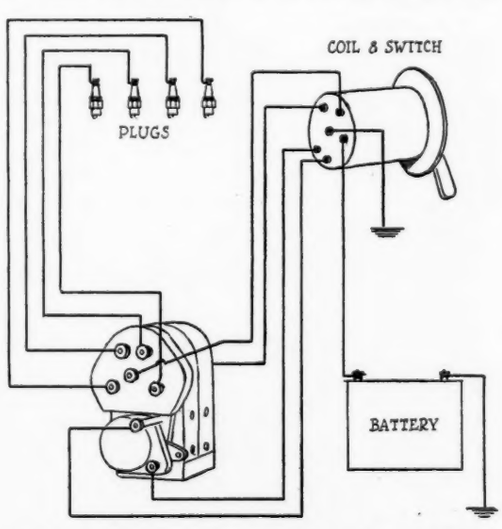


Fig. 1—Left—Top center and advanced firing positions. Fig 2—Right—Wiring diagram of a dual ignition system

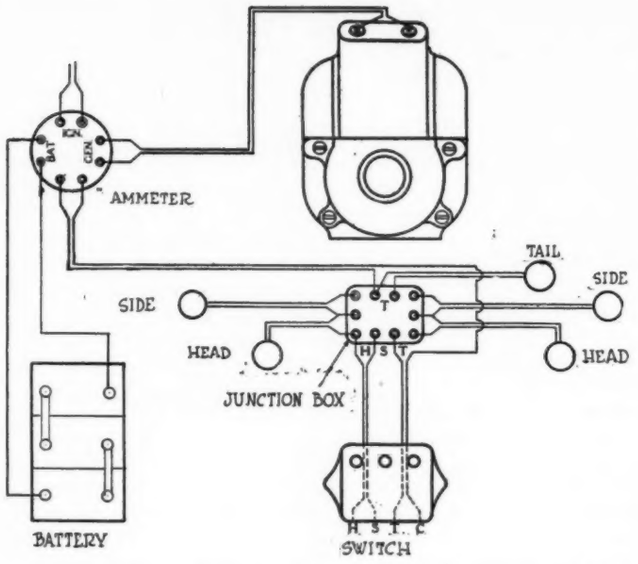


Fig. 3—Wiring diagram of the Remy electric system on the Stutz

wheel is rotating 90.9 times in 1 min. while a 36-in. wheel is rotating 93.4 times. Or to put it another way, if the 37-in. wheel is rotating 100 times in a minute the car will be traveling 11 m.p.h. The 36-in. wheel will have to rotate 102.7 times a minute for the speedometer to indicate 11 m.p.h.

With the conditions above outlined holding true the speed readings on your speedometer and the distance readings will be about 97 per cent of what they should be.

Correct Setting of Fixed Spark

Editor THE AUTOMOBILE:—I saw an article in a recent issue about set spark. It stated the piston should be within ½ in. of top on compression stroke when the spark should occur. Is this right? If so, I have been setting mine wrong. My engine has a set spark and the only gas control is a foot accelerator. Now when the throttle is closed for idle running I have my spark occur when the piston is at top dead center on compression stroke. If I change it to occur ½ in. before top center will it be all right? What is the best position for the most power obtainable? The markings on the engine are entirely gone so I am depending on your best judgment.

New Durham, N. J. S. A.

—Carry the spark as far ahead as you can without having the engine knock and without having it kick back in starting. The distance in advance of dead center depends on the speed of the motor and on the type of ignition apparatus. This is true because the higher the motor speed the further in advance should be the spark, and the greater the mechanical and electrical lag in the ignition apparatus the further ahead the spark should be set.

Diagram of Remy Electric System

Editor THE AUTOMOBILE:—Please publish a wiring diagram of the Remy starting and lighting system as used on Stutz roadster, starting motor model five, lighting generator model 0.

2—Is this system typical of all Stutz cars?

3—Describe the Bosch waterproof magneto as used on this car.

4—Where can the S. A. E. handbook be obtained, and what is the price of it?

Montreal, Canada. J. W.

—The wiring diagram you request is illustrated in Fig. 3. No diagram of the starter wiring is available as it is simply a two-wire system direct from the battery to the starter with the switch cut in.

2—Yes. This is typical of all Stutz cars.

3—This is a regular stock model Bosch magneto. The magneto model is the Z-R four or six in accordance with whether the car has four or six cylinders. It is very similar to the familiar Bosch DU type magnetos except that it is provided with a waterproof cover.

4—The handbook can be secured from the Society of Automobile Engineers, 29 West Thirty-ninth Street, New York City. The price for the two volumes is $7.

Wants Definition of Torque

Editor THE AUTOMOBILE:—Kindly define and explain the word torque as applied to automobiles.

Rochester, N. Y. J. D. M.

—The word torque is a definite one and means the same whether referred to automobiles or any other piece of mechanism. It is the force which tends to produce rotation or torsion and is measured tangentially by multiplying the force by the radius about the axis of rotation. That is, the torque in a given shaft would be equal to the power applied to the shaft times the distance of the tangential point of application from the axis of the shaft.

A Plea for Amateur Racing

Editor THE AUTOMOBILE:—In these days, when automobile racing, after some bad years, is so rapidly regaining its interest and popularity with the public, it seems strange that some serious effort is not being made to build up the amateur side of the sport. The publicity for the manufacturers, to be gained from stock, or even special, cars raced by non-professionals is tremendous, and furthermore it would be cheap, which can hardly be said for factory teams. From the standpoint of the promoter, a larger and more interested crowd than at any, except the very greatest, professional races would be assured from the friends of, and club and city "rooters" for, the various amateurs. Also, the prizes, as an inducement for entering, would not have to be so large. The potential purchasing power of the amateur and his friends is, also, by no means to be neglected.

There seem to be two particular reasons why promoters are averse to running an event of this class, the first being that they believe there are no eligibles, under the definition of the A. A. A., who would dare to race, and the second that, even if there were, their lack of skill would render them a menace to each other and the spectators, as well.

In regard to the first reason, the cause is to be found in the fact that no attempt is ever made to canvass the owners of fast cars who have the time and money for sport. Secondly, if some publicity was given the idea in the press, a surprising number of additional prospects would come forward, once the actual conditions of the contest were explained to them, and they were assured of meeting a class of cars and drivers of the same general ability as their own.

In regard to the second reason, the simple fact that a man is willing to receive money for racing is no reason that it should at once endow him with a superior competency to that of the man who is not. If experience was a requirement for drivers' certificates, the situation might be different, but this is not the case. There are any number of young men in this country who can, and do, drive fast, and are perfectly competent to handle cars at speed. If given a chance, they should show surprising ability. At any rate, the amateur's car would not be as speedy a proposition as the professionals', and the danger would be proportionally lessened.

It might be a good idea to hold some of the first races on "dangerous" courses, that is to say, those on which sharp

turns and rough surfaces would keep down the speed to a point where a wreck would, probably, not be serious, and where the ability of the men could be better observed than on a perfectly banked speedway, where the average would be high, and good luck in not blowing a tire at a bad place would count more than good driving.

The writer, recently, tried to interest the management of the Panama-California Exposition in holding, in connection with the race of March 25, an amateur event. The course exactly met the above requirements, Burman's winning speed, in a Peugeot, being only a little better than 50 miles. Spectators were amply protected by bales of hay. The Exposition management declined to follow the suggestion, for the reason herewith quoted from their letter.

"The idea . . . would be a valuable special event, but for the fact that the course here is so difficult as to entirely prevent any amateur driving. . . . The condition is not due to the fact that they cannot drive well enough, but rather to the fact that they may become over-enthusiastic and an accident would result."

That over-enthusiasm is a failing by no means confined to the amateur was shown rather clearly, a few days later, in the March 26 *Los Angeles Times*' story of the race.

"On the opening lap, Burman, Tetzlaff and Durant overran the hair-pin turn in front of the Cristobal Cafe, and plowed through an opening in the banked baled hay, running into a jam in the safety zone. . . . In the mix-up the Durant Special lost three spokes out of the left rear wheel and bent the frame in several places. The Milac inherited a battle scar on the rear end of its gas tank." Comment is unnecessary!

Del Mar, Cal. JOHN F. GRAY.

What Makes Electric Current Flow

Editor THE AUTOMOBILE:—What makes current flow? I have read the article entitled, Automobile Electricity in THE AUTOMOBILE for April 6, and I would like to know what it is that makes the current flow through the electric circle.

New York City. D. M. L.

—Electricity travels from the point of higher pressure to that of lower pressure. It travels in measurable quantities and since these quantities have direction of flow and pressure they are capable of performing work. Electrical pressure can be measured by standard units. Water or air pressure is denoted by pounds to the square inch. Electrical pressure is measured by volts. The amount of water flowing through a pipe is calculated in gallons per minute. The quantity of electrical current flowing through a wire is calculated in amperes. Resistance to flow of water through pipes is given by the coefficient of friction and by measuring the obstructions in the pipe. Resistance to electrical flow is measured in ohms.

The amount of current flowing is equivalent to the pressure divided by the resistance or, using the units of measurement just defined, amperes equals volts divided by ohms.

This equation is the basis of practically all electrical calculations. A practical example is in a lamp. If we take a headlamp of 12 cp. and say that it has a resistance of 3 ohms. and that it is intended for a 6-volt circuit it is possible to determine at once how many amperes are necessary to light the lamp. Applying the equation the amount of current is equal to 6 volts divided by 3 ohms or 2 amp.

Taking the simple elementary case mentioned before of a battery, a switch and a lamp, the resistance to the flow in the circuit is encountered in the wire, in the switch and in the lamp. The wire acts for the current the same as the pipe does for water. The smaller the pipe the greater the amount of resistance to flow. The smaller the wire the greater the resistance to the electric current. Poor connections between the wire and the switch would introduce resistance into the line as the current would be compelled to flow through the poorly-made contact at the points of connection. This would utilize some of the pressure that could otherwise be employed in lighting the lamp and the result is that the lamp would be dim. If it takes 6 volts pressure to bring the lamp to the proper degree of brightness and other resistances in the line due to poor connections, etc., weaken the pressure at the lamp until it is down to 4 volts, the lamp instead of lighting brightly will light dimly. If the resistance in the line becomes so great that current cannot flow at all the lamp will go out. When the circuit is broken due to the fracture of a wire, for instance, or the disconnection of a lead the current is interrupted and flow ceases.

If an extremely high-tension circuit were used, or in other words, a circuit in which the pressure or voltage ran up to thousands of volts, a small break in the wire would not be a means of altogether interrupting the current as the pressure would be sufficient for the electrical current to be forced acoss the gap in spite of the resistance of the air. Such an occurrence takes place in the high-tension ignition system where the current circle is completed by the high tension spark caused by the current jumping across the gaps between the electrodes in the spark plug.

Using Camphor Gum in Fuel

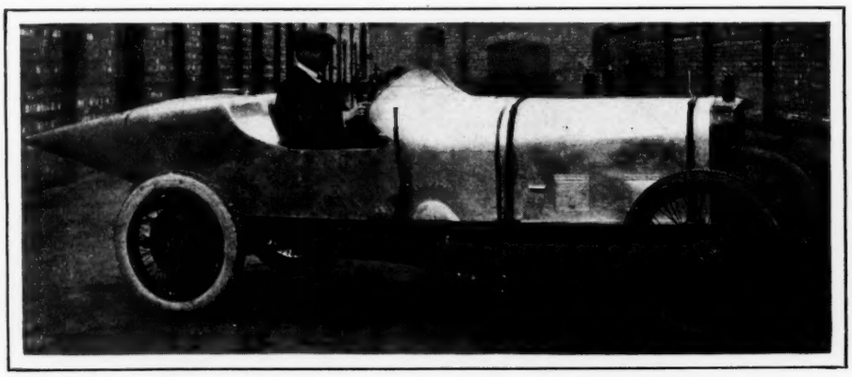
Editor THE AUTOMOBILE:—What advantage is gained in adding camphor gum to gasoline for fuel? I am told to mix 2 oz. camphor gum to 10 gal. gasoline to improve mileage from 10 to 15 per cent. Does it improve the mileage and does it affect the cylinders to add ether to the gasoline?

Cleveland, Ohio. A. D. S.

—THE AUTOMOBILE does not recommend the use of camphor gum in fuel.

New Sunbeam for Sheepshead Bay Races

AS announced in THE AUTOMOBILE for April 20, Louis Coatalen, of the Sunbeam factory, has cabled to the management of the Sheepshead Bay Motor Speedway Corp. the entry in a new Sunbeam racer of Joseph Christiaens at the Sheepshead Bay opening scheduled for May 13. The car is a 1916 model, it is stated, which has never raced before, but, according to reports from Brooklands, it has developed a speed of 116 m.p.h. Christiaens and the car have already reached this country. The illustration shows Louis Coatalen at the wheel of the new racer.



Trailers in Many Sizes

Miami Line of Vehicles Specially Designed for Automobile Work Range from 800-lb. to Four-Wheel 1250-lb.

IT very frequently becomes necessary in depot, bus and taxi work to carry large pieces of luggage along with the passengers. Where a small trunk is all that is necessary it can be readily put up on the driver's seat and will not interfere greatly with his movements. On the other hand, there are a large number of instances where the passenger would like to have several large pieces of baggage delivered at the same time that he is. To handle work of this kind the Miami Trailer Co., of Troy, Miami County, Ohio, has brought out a line of trailers designed and built especially for automobile speeds.

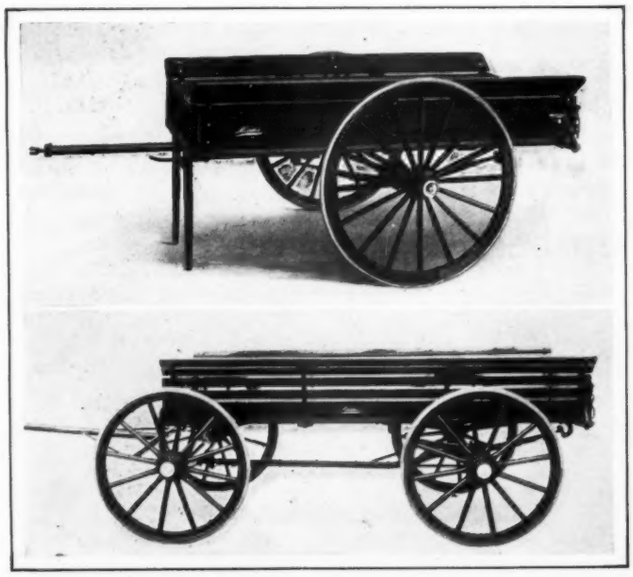
The present line comprises five models of different capacities and sizes, all of which are capable of being fastened behind passenger cars by means of a special shock-absorbing drawbar arrangement. The fundamental features of these trailers are centered about the fact that they can readily be attached to a passenger car and are capable of traveling at the speeds ordinarily used with vehicles of this type.

Attached to Chassis

Attachment of the trailer is made to the chassis or sprung part of the car and not to the unsprung axle. Thus there is no tendency on the part of the trailer to increase the proportionate unsprung weight. The axles and bearings used in the construction of the trailers are of the same grade as those used in automobiles and in the case of the four-wheel trailers they are designed to follow or trail perfectly with the automobile.

Wide Range of Sizes

In size the trailers range from a two-wheel 800-lb. vehicle to a four-wheel type with a carrying capacity of 1250 lb.



Above—Model 3 Miami trailer with 9-in. panel body
Below—Model 2, which has an 8-in. flareboard and is of solid oak lined with steel

Standard automobile axles and bearings are used in the construction of Miami trailers

The weights of the trailers in themselves range from 290 lb. up to 500 lb. The models are known as 1, 1A, 2, 3 and 4.

Models 1 and 2 each have a carrying capacity of over 1200 lb., the rating of No. 1 being 1250 and No. 2, 1230. No. 1A is a modification of No. 1 with pneumatic tires 30 by 3 in. in size in place of the solid tires used on No. 1. The technical specifications of these little trailers of over 1200 lb. capacity show them to have 1¼-in. Timken axles equipped with Timken roller bearings. They have regulation artillery wheels, 32-in. in diameter both front and rear, except on the vehicles which take the 30 by 3-in. tires. Specially designed, short-turn gears to assist in proper tracking are employed and the spring mounting is semi-elliptic with 1½ by 38-in. front and rear springs, the front having six leaves and the rear five.

Standard Tread Dimension

The tread of these trailers is 56-in. standard and the height from the ground to the bed is 26-in. The shock-absorbing drawbar previously mentioned is employed and the wheelbase is 70 in. For body equipment the No. 1 design has a 10-in. panel type, 96 by 38 in. in interior dimensions with a 6-in. flare board. There is a drop end gate with chain.

Body No. 2 has the same internal dimensions with an 8-in. flareboard and is of solid oak, steel lined. The finish is black, striped and varnished and an electric tail light is provided to conform with traffic ordinances.

Model No. 3 is a two-wheel vehicle having 1¼-in. axles and solid rubber tires. The body in this case is a 9-in. panel type with interior dimensions 78 by 38 and a 5-in. flareboard. Its carrying capacity is 1000 lb.

Model No. 4, the smallest type, has a 1⅛-in. coach axle with plain taper bearings. The wheels are 32-in. artillery type with 1¼-in. solid tires. Semi-elliptic springs of 1½-in. width and five leaves are used. The tread is standard 56-in. and the body 78 by 38 in. with 8-in. panel and 5-in. flareboard. The weight of this little vehicle is 290 lb.

Bodies for Special Purposes

For special purposes the Miami company will make bodies to order, but for all ordinary work the line described should apply. These small trailers should be particularly useful in carying baggage from the small hotel to the railroad depot. An ordinary size car is generally sufficient to meet the requirements of passenger traffic, but for baggage work the local express company or some other vehicle must often be relied upon. The upkeep of a small trailer of this kind is very low and the parts of which it is composed are as substantial as those on the small automobile. In fact, they are exactly similar to automobile parts.

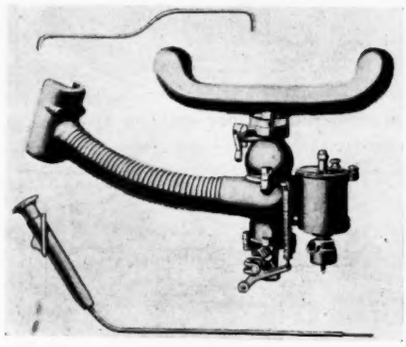
ACCESSORIES

Stewart Carbureter for Fords

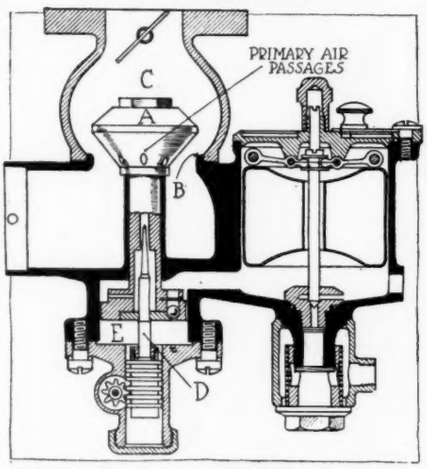
A SPECIAL carbureter for Ford cars has been added to the Stewart line. This instrument works on the same metering-pin principle as the other Stewart instruments, but is designed for the needs of the Ford engine. Besides the carbureter itself, a manifold, hot air connections, dash adjustment and all fittings are included in the outfit as retailed at $15.

The principle of the Stewart carbureter may best be understood from the sectional view. The metering valve *A* rests upon the seat *B* when the engine is not running, but as the engine begins to rotate, the suction raises the valve from the seat, drawing in air around it from the air intake. This suction also draws gasoline up within the valve stem, this mixing with the incoming air in the chamber *C*. The Stewart has but one adjustment, that being for the amount of gasoline. The air is a fixed amount, it being simply necessary to regulate the amount of gasoline admitted. This is controlled by the tapered metering pin *D*, and the adjustment is made when the engine is running at idling speed. By turning the adjusting screw either to the right or left, the position of the metering pin is raised or lowered, thereby allowing a greater or less supply of fuel to be drawn up into the mixing chamber. When the right proportion has been determined at low speed, it is evident that as the speed of the engine increases, the metering valve *A* raises higher from its seat and away from the metering pin *D*. This allows a greater supply of both gasoline and air to be admitted in the right proportions as predetermined when designing the instrument.

In the Ford type of Stewart carbureter the float bowl is furnished in either one of two positions. Some Fords are specially equipped with a high-tension magneto, in which case it will be necessary to have the bowl at right angles to the air port or between the carbureter body and the hood base of the car. Where there is no high-tension magneto installation, the float bowl is placed at 180 deg. to the air port, or forward of the carbureter body.—Detroit Lubricator Co., Detroit, Mich.



Stewart carbureter for Fords, with manifold mounting indicated



Section through new Stewart carbureter

Du Bois two-piece piston ring

Du Bois Piston Ring

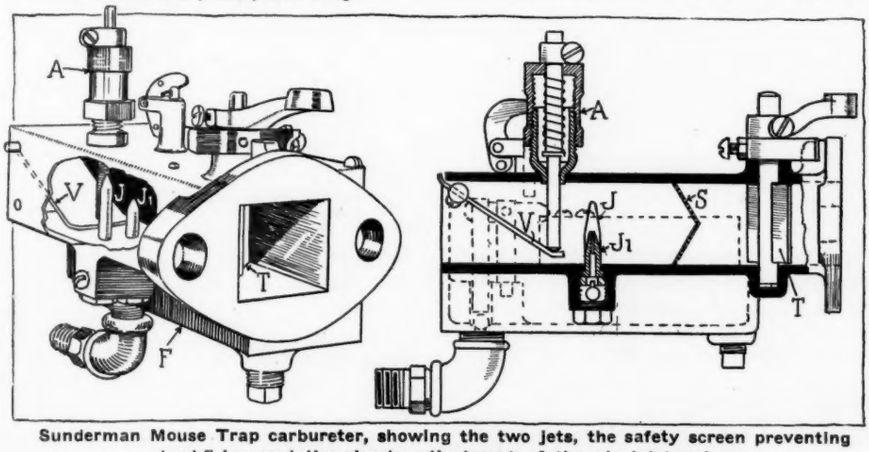
The Du Bois is a two-piece concentric ring. One section is the full width of the piston groove and is of L-shaped cross section, while the other is smaller and fits into the angle of the larger part. The splits come at diametrically opposite points; the width of the large ring is such that it seals the split in the small one, while the latter has a projecting part to seal the split in the wide ring. The makers claim particularly that the ring produces a good vacuum in the cylinder, so that the full charge is drawn in at each intake stroke.—Du Bois Machine Shop, Inc., Albany, N. Y.

Sunderman Mouse Trap Carbureter

Simple in construction and in adjustment, this carbureter is claimed to feed pure combustible gas from cold kerosene or gasoline to the motor without changing the adjustment, no hot air or water jacket being needed. As shown in the illustration, the rectangular float chamber *F*, fitted with a primer, is adjacent to the mixing chamber, which is simply a square passage. The fuel is admitted to this passage through the jet *J*1 for low speeds and when idling and when the speed is increased the taller jet *J* automatically comes into play so that both jets are operating at once.

Air is drawn through the valve *V*, which is regulated by the tension on the spring controlled by the adjusting collar *A*. In the illustration the air intake door is shown in the position it assumes when the motor is idling and fuel is being fed through the short jet *J*1 only. As the air rushes into the vacuum behind the intake door it sweeps the globules of fuel from the jets and the resulting vapor is further disintegrated into a homogeneous mixture by passing through the screen *S*, after which it passes the throttle *T* on its way through the manifold to the combustion chamber.

Besides an unusually high degree of fuel economy, the makers claim the carbureter gives great flexibility with consequent minimized gear shifting. The screen *S* prevents backfiring with its attendant dangers, and the elimination of a gasoline adjustment by the use of the regulating jets renders adjustment extremely simple. In fact, the makers state that when the carbureter is once set correctly, fur-



Sunderman Mouse Trap carbureter, showing the two jets, the safety screen preventing backfiring and the simple adjustment of the air inlet valve

ther changes will be entirely unnecessary.

The carbureter is made in brass, iron or aluminum alloy, in ¾ in., 1 in., 1⅛ in. and 1¼ in. sizes, under the names of models *A*, *B*, *F* and *C*, respectively, and as the model Twin *F* for eight or twelve-cylinder cars. Model *F* weighs 1¾ lb. in brass or iron and 10 oz. in aluminum alloy, and is 4½ by 2½ by 1⅞ in.—Sunderman Corp., Newburgh, N. Y., maker. J. F. Renfro Co., Inc., New York City, sole factory distributor.

Eclipse Piston Ring

The Eclipse ring is composed of two rings, one of which is an eccentric L ring and the other flat and concentric. The eccentric ring, which is designed to secure an even pressure at all points around the cylinder, is held tight at the joint by the concentric ring so that it conforms exactly to the cylinder diameter. A straight cut in the eccentric ring prevents compression turning the outside ring around on the eccentric ring so that pins are unnecessary and weak spots are eliminated. The entire ring can float around inside the piston, without impairing compression. Eclipse rings are made of gray iron and are guaranteed to fit in any diameter and width. A feature of this ring's construction is that it prevents leaks of gas and oil and lengthens the life of unground cylinders.—Hope Machine Co., manufacturer; Edwin T. Craven Co., Philadelphia, Pa., sole distributor.

Bell Air Valves

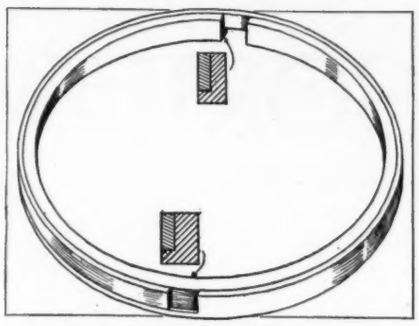
The Evertite valve is made in ¼, ⅜ and ½-in. sizes; the enlarged stem end and the peculiar corrugations make it practically impossible for the hose to be blown off. The Premier combination consists of an Evertite valve combined with a tire gage. The Automatic Electric not only registers air pressure, but also automatically controls the current for the electric pump motor; with this valve the makers state that a storage tank can be dispensed with and there is no pressure on the hose except when a tire is being inflated. Prices, Premier, $3; Automatic Electric, $8.50; Evertite, $1.—Bell Brass Mfg. Co., 205 White Building, Seattle, Wash.

Spee-Dee Hand Cleaner

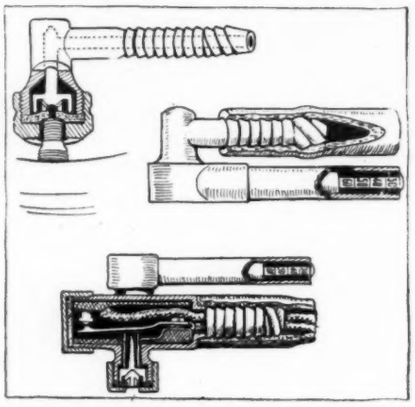
The Spee-Dee cleaner is a solvent for grease and when applied to the hands it takes up all dirt, leaving the hands clean when wiped off. It is used without water. The maker states that it does not injure the skin in the least. The emulsion can be mixed with water and used to clean oily motor parts. Spee-Dee sells for 15 cents per can.—States Chemical Co., Chicago, Ill.

Economy Manifold

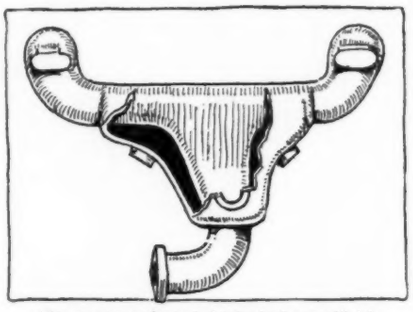
The Economy special intake manifold has a jacket through which part of the exhaust gas is passed, heating the intake and the vapor which passes through it and bringing the mixture to a more completely combustible state. The maker states that carbon deposits are reduced and gasoline consumption lessened by the use of this appliance. There are no adjustments and no loose parts. Manifolds will fit any Ford from 1909 to date. Price, $6 attached.—Economy Manifold Co., Syracuse, N. Y.



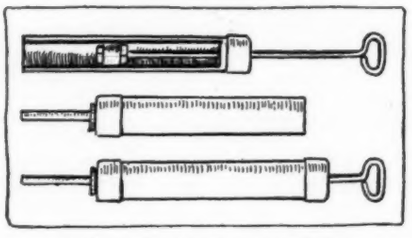
Eclipse piston ring, showing section



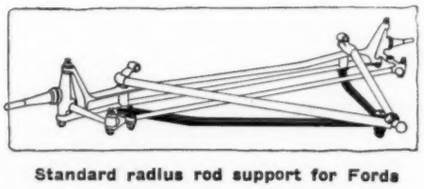
Three types of Bell air valves



Economy exhaust-jacketed manifold



Puritan easy-loading grease gun



Standard radius rod support for Fords

Puritan Grease Gun

The Puritan grease gun is ingeniously filled. There is an inner tube which can be withdrawn when the plunger is drawn up as far as it will go; the tube is filled with grease and inserted in the gun and expelled in the usual way. The tube can be inserted in one position only. so that it cannot be put in wrong. The gun sells for $1.50.—Puritan Mfg. Co., Bridgeport, Conn.

Standard Radius Rod Support

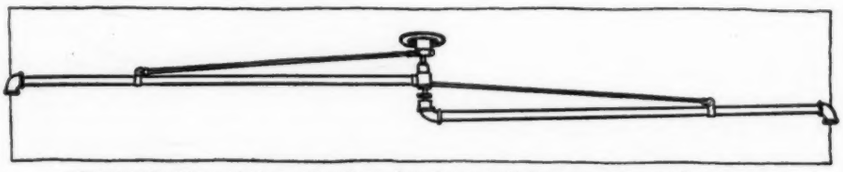
In this device steel tubing radius rods are installed on the Ford car in the same position as the regular radius rods, except that they attach below the front axle instead of above it. They are held by the spring hanger bolts on the axle and in the rear at the ball-and-socket joint just in front of the magneto casing. The object is to stiffen up the front axle system and incidentally to steady the steering of the car. Price $1.50.—Standard Auto Accessory Co., Leipsic, Ohio.

Raban Revolving Washer

Washers are made in several different styles but the general features claimed for all of them are simplicity and a method of support which removes all strain from the working parts. The Leader, which lists at $17, is provided with an inside valve which is said to prevent leakage even when the pressure is abnormal. Price $15 to $35.—W. A. Raban, Port Chester, New York.

Sexton's Castor Motor Oil

Castor oil and vegetable and mineral oils are compounded in such proportions as to form a lubricant said to possess the desirable qualities of pure castor oil without its drawbacks. The lubricant is made suitable for any service by varying the proportions of castor and other oils, and various grades are made that are suitable for various motors, their individual characteristics being taken into consideration. The price is about the same as that of the highest grade mineral lubricating oils.—Sexton Oil Co., Chicago, Ill.



Raban double-ended overhead washer to permit two men to work at once

The Automobile

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British Taxation

THE recently issued British order in Council which prohibits the importation of passenger cars, parts and accessories is bound to have a serious effect upon the dealers of the United Kingdom as the latter have lately been depending almost entirely upon American supplies to maintain their business. The prohibition of importation of parts appears likely to work some hardship upon British owners of American cars, though it is to be presumed that the big distributors like the Ford and Overland branches in England carry sufficient spare parts to care for their customers' wants for a fair period.

Following the importation prohibition, however, comes the new taxation imposed by the budget for 1916. This increases the annual license fees which are paid to the national exchequer by 100 per cent on small cars and 200 per cent on larger machines. To give an example, the old taxes which have been in force for some time made the annual tax on a Ford car $30.24 and this is now raised to $90.72. The tax is based upon a horsepower formula exactly similar to the A. L. A. M. and the $90 tax is payable on all four-cylinder cars having a bore over 3 5/32 in. on sixes with a bore exceeding 2 9/16 in. and on eights with a bore over 2 3/16 in.

Nor is the $90 tax the worst, for there are three other stages. Cars rating over 26 hp. are charged $126 per annum, over 33 hp. $156, over 40 hp. $315 and cars over 60 hp. rating $630, the conversions to dollars being in round figures.

It is highly improbable that these motor car taxes will be reduced directly upon the declaration of peace and the removal of the importation prohibition, which latter will almost certainly be discontinued as soon as the Atlantic freight situation eases. This means that for some years to come there will probably be a premium upon cars with a bore of 80 mm. (3 5/32 in.) or under, as this is the limit of bore for fours to come under the $90 tax. The rating of this size of engine is 15.8 hp. and practically every American car exceeds this amount considerably. It means that the quite small, high-speed four is going to be the favorite car for export to Great Britain.

What of the Four?

A YEAR ago when the six versus eight argument was at its height, when the twelve was about to make its bow to the public and cylinders were the main topic of engineering conversation, there were many who expressed the view that all the discussion would serve to draw attention to the advantages of the four. The highly successful meeting of the Metropolitan section of the S. A. E. last week, at which the future of the four was the topic of the evening, proves that interest in the four is reawakening.

It means something more than the swing of the pendulum. Probably it marks the first step in the commencement of the endeavor to reduce the cost of operating an automobile, which appears to be one of the most important problems now facing engineers.

It is agreed that the demand for large, heavy cars will be limited in the future, and that the highly efficient, light machine is the coming type. Such a car may prove to be most easily made with any number of cylinders, but undoubtedly the four shows to better advantage as the total size of the engine is reduced.

There is a very general feeling that a small four with the highest possible class of internal and external finish would command a good price and sell in considerable quantities. It may be either right or wrong, but while it lasts interest in the four will continue.

Comprehending Carburetion

THE paper read in Cleveland by F. H. Ball and F. O. Ball is noteworthy because it shows in a very graphic manner just what are the main problems of successful carburetion. The diagrams showing the action of the various types of instruments enable the essential functions of the different parts that go to carbureter makeup to be clearly grasped, and the effect of altering one part or another to be appreciated.

From the diagrams we see how comparatively difficult it is to hold the mixture curve of a carbureter within the effective zone, giving a mixture neither too rich nor too strong.

Cleveland Meeting Shows Progress In Standardization by S. A. E.

Few New Standards Actually Recommended But Progress Reports of Divisions Indicate Full Program for Summer Meeting—Some Big Things in Hand

CLEVELAND, OHIO, April 21—Laying down the details of the proposed form for fuel economy testing of automobiles provided the highest spot in the meeting of the S. A. E. Standards Committee held at the Statler Hotel to-day. There was a large attendance, some seventy members participating in the discussions, and reports were received from all divisions of the committee. It was made clear that all divisions with but two exceptions, have programs before them which will provide work for the rest of the year; there has never been a time when more important matters were before the Society.

A very noticeable feature of the meeting was the tendency to ask for data of a fundamental nature. In discussing the reports of the divisions there were several demands for purely scientific treatment of the problems; demands that the theory of the subject be considered more fully than current practice in establishing new recommendations.

Tire Standards Division

An important vote was one recommending the Council to appoint a new division of the committee to be called the Tire Standards Division. Hitherto matters relating to solid tires have been handled by the truck division and there has been one division with a special interest in pneumatic tires. It is felt that there is need for a careful analysis of such things as the proper loads and air pressures for tires of different sizes, the comparative durabilty of solid tires of different sections and so forth. The new division would be entrusted with research work along such lines and would endeavor to develop S. A. E. recommendations to which all tire makers could subscribe. It is also thought probable that a standardization of passenger car felloe bands is now possible which would make rims of different type interchangeable, and the examination of this subject would be one of the new division's first tasks.

Seek Ability Formula

The most vigorous discussion of the day took place at the afternoon session, on the presentation of the report of the research division which is given complete on page 790. The report is an amendment of one presented to the January meeting and turned back as insufficiently rigid. The report as now presented was accepted, but only as a progress report, the committee thinking that the recommended test ought to cover acceleration and other things. The research division is thus entrusted with the expansion of the scheme for fuel economy testing into a comprehensive test which will show everything about a car that can be tested.

The discussion was very general, among the speakers being C. T. Myers, Timken-David Brown Co.; Professor Fishleigh, Michigan University; K. W. Zimmerschied, past chairman Standards Committee, and E. E. Sweet, Cadillac Motor Car Co. The possibility of an "ability formula," which has long been an ideal, was the main subject. Engineers in various parts of the world have for years past been trying to find some method of testing which would enable a figure of merit of some kind to be given a car that would include everything, economy, speed, acceleration, weight, etc. Mr. Myers held that it was possible to develop a test which would give satisfactory results and J. Younger, Pierce-Arrow Motor Car Co., drew attention to the close similarity of the theoretical work done by independent investigators. It was finally voted to accept the report as far as it went, but not to recommend its adoption by the Society till the research division had completely examined the ability formula idea and reported to the Standards Committee.

Speedometer Drive Details

The Miscellaneous Division is one that always has a full slate, and the report read by J. G. Utz, chairman of the division, showed that there was much in hand. This also was a progress report, nothing being quite ready for adoption, though several things are near that stage. Mr. Utz explained the proposed speedometer drive connection, which is now being examined by manufacturers. This consists of a socket with a shaft and a flange for attaching to any convenient part of the gearbox. It is proposed that the gearbox maker should provide the original driving gear within the gearset so that the speedometer manufacturer would furnish a standard end to the flexible drive which would fit the standard socket. The nest of gears giving opportunity for variation to suit tire size and gear ratio could be either within the gearbox or outside. It seems certain that this standard will go through without much difficulty, though the design may be altered a good deal. The present idea provides quite a small flange on the gearbox and E. G. Gunn, Premier Motor Corp., suggested that it might be well to make the hole larger, so that the nest of gears could be inserted from outside the gearset and thus accommodate the different ratios required without pulling apart the transmission.

In discussing this drive the error caused by using rear wheel drive for the speedometer was mentioned. Berne Nadall, Stewart-Warner Corp, stated that this did not exceed 1.5 per cent under ordinary circumstances and was no greater than the error caused by variations in tire diameter away from nominal size. E. E. Sweet added that this tire variation was surprisingly great, saying that he had found tires of the same nominal size which varied in circumference as much as 5 in.

Next in the list of this division are recommendations for the depth of piston ring grooves, this following previous work in connection with their width. A formula for determining the width in terms of the piston diameter is

$$G = \sqrt{\frac{.01\ D^2}{8}} + .005$$

and this appears to give very good results, providing a groove which will accommodate nearly all types of ring. This will be ready for acceptance by the Society in June.

A very small detail of substantial importance which the Miscellaneous division is about to standardize is the thread on the top extremity of spark plugs, so that any spark plug nut will fit. Seeing the ease with which these terminal nuts can be lost, this should be a standard much appreciated by the general public.

It was voted that the recommended practice for gearshift gates or lever positions should be given in the data book as follows—left side, reverse forward, low gear back; right side, intermediate forward, high back. This setting is stated to be now used by 82 per cent of makers. Recommendations for four speed positions are to be removed.

C. W. McKinley, Willys-Overland Co., asked that the Miscellaneous division give attention to the length of thread on S. A. E. bolts saying that this was now so short that the usefulness of the standard bolt was greatly curtailed.

Lamp Investigations

The Electrical Equipment division has held two formal and one informal meetings during the past few weeks, the chief work done being the appointment of a sub-committee under the chairmanship of W. E. McKetchnie, Cadillac Motor Car Co., to confer upon lamp standardization; of another committee under chairmanship of F. Conrad, Westinghouse Elect. & Mfg. Co., on generator, starting

(*Continued on page* 789)

Plan $5,000,000 Ford Plant

80 Acres Bought in Newark, N. J.—To Expand Chicago Plant

DETROIT, MICH., April 24—The Ford Motor Co. has acquired 80 acres of land just outside of Newark, N. J., on which it is planned to erect a service station and assembly plant, at a cost of about $5,000,000.

Frank L. Klingensmith, vice-president and treasurer of the Ford company, states that no definite ideas have been formulated beyond the fact that an assembly plant and service station similar to the one at Long Island City is to be erected. The tract is large enough to erect any sort of plants the Ford company may need in the future and the move is more in the nature of a step to meet any later needs of the company in the way of expansion in the Eastern territory. It is pointed out that inasmuch as the tract could be bought at a reasonable figure, it was acquired without any definite idea as to exactly how it would all be utilized. There is a hint that possibly an Eastern unit of the Ford tractor business will find its location on this tract and also that an export factory will be erected.

Coincident with the news that the Ford company had acquired property near New York City, it has also been learned that a plot, 100 by 161 ft. on Michigan Avenue, Chicago, has been acquired. This adjoins the new assembly plant recently completed in that city and will be utilized for enlarging this building when occasion demands. Another lot 75 by 121 ft. has also been acquired in Chicago at the corner of West Madison and Kildare avenues, where a service station may be located.

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Murray New Eight

PITTSBURGH, PA., April 25 — The Murray Motor Car Co. has been organized here to manufacture the Murray touring car, an eight-cylinder design with seven-passenger accommodation with 127-in. wheelbase for car and roadster types. W. B. Murray, who has been connected with Packard distribution in this city, is president and associated with him are J. W. Pontefract and W. W. Bensel. Fred Berger is chief engineer and Joseph Gardham production manager. A factory has been secured at 3700 Grand Boulevard, and materials have been contracted for.

The car will largely be an assembled one, using a unit power plant composed of an eight-cylinder Herschell-Spillman motor 3¼ by 5, and a Covert gearset. Other parts to be used are Timken axles, Perfection springs, Parish & Bingham frame, Gemmer steering gear and Blood universals. At this time it is not definite what electrical equipment will be used, but it is expected that Westinghouse starting and lighting equipment will be standard. Bosch ignition will be fitted. The price has not been decided upon, but it will be in the zone of $2,000.

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Two New Jeffery Trucks

KENOSHA, WIS., April 22—The Thos. B. Jeffery Co. of this city has added two new trucks to its line. One is a 1500-lb. capacity car at $900, which follows along the lines of the four-cylinder passenger car design and the other is a 3000-lb. truck, selling at $1,400 and of heavier construction throughout as compared with the lighter one, but nevertheless of somewhat similar design.

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Briscoe Advances Prices

JACKSON, MICH., April 24—The Briscoe Motor Corp., this city, has raised its prices $40 on the 4-24 to $625; $35 to $785 on the 4-38, and $35 to $985 on the eight-cylinder model. The prices went into effect April 15.

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Argo Raises Prices $20

JACKSON, MICH., April 24—The Argo Motor Co., Inc., announces that due to the higher cost of materials and improvements in construction of the Argo cars, the price of the touring car has been raised from $435 to $455, and the roadster from $385 to $405, an increase of $20 on each model.

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Sears-Cross Lowers Prices

BROOKLYN, N. Y., April 21.—The Sears-Cross Co., this city, on March 25 reduced the prices of its speedometers. Model F-15, for Fords, has been reduced from $12 to $8; model FF-16, also for Fords, has been reduced from $15 to $10, and the F.C.M.B. model has been reduced from $25 to $12.

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New Company to Take Over Standard Roller Bearing

PHILADELPHIA, PA., April 21—The reorganization committee of the Standard Roller Bearing Co. has agreed on the tentative plan for refinancing the company which was outlined in THE AUTOMOBILE for Jan. 6, 1916. Under this plan the holders of debenture gold 5's maturing April 2, 1916, convertible gold 6's due March 2, 1918, bills payable and accounts payable are to receive in cash 20 per cent of the principal of their claims, and the balance of the principal of their claims, 80 per cent in second preferred stock, in a new company to be organized to purchase the old company.

Overland Wages Up 4 to 10

17,000 Employees Affected by New Pay Schedule in Effect June 1

TOLEDO, OHIO, April 21—Effective June 1, about 17,000 factory employees of the Willys-Overland Co. will receive an increase in wages ranging from 4 to 10 per cent and a reduced schedule of hours.

The shops of the company will be operated on an 8-hr. basis, the present working time being 50 hr. a week. The company will give 50-hr. pay for 48-hr. work. All the advances are voluntary on the part of the company.

This means that the company's payroll for factory employees, now about $250,000 a week, will be increased to $275,000 a week. It also means an annual distribution of wages amounting in round numbers to $14,300,000.

According to the special factory notice, beginning June 1, all factory employees receiving 25 cents or less per hour will then receive an increase of 10 per cent. Those now receiving over 25 cents and up to and including 30 cents per hour, will receive an increase of 7 per cent. Those now receiving over 30 cents per hour will receive an increase of 4 per cent.

As in the past the company will pay time and one-half for overtime, and double time for Sundays and holidays.

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Winton Raises Wages 10 per Cent

CLEVELAND, OHIO, April 22—The announcement is made by the Winton Co. that all of the employees will be given an advance of 10 per cent in wages, effective May 1. In all 1300 men are affected by the increase.

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Jordan Plant to Be Completed June 1

CLEVELAND, OHIO, April 21—The first unit of the new Jordan Motor Car Co. plant on East 152d Street, this city, will be completed by June 1 and production of the Jordan car will begin soon after that date.

The first building of the plant group will include 30,000 sq. ft. of floor space and will cost about $50,000.

It is understood that the six-cylinder chassis will contain the one best unit produced by each one of the leading makers among parts producing companies in America.

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To Sell Lauth-Juergens Assets

FREMONT, OHIO, April 22—The stockholders of the Lauth-Juergens Motor Truck Co. will meet April 25 to vote on the adoption of an agreement for the sale of the entire property and assets of the company to the H. G. Burford Co.

Packard Makes 116 M. P. H.

Special Car with 300-In. Aeroplane Engine Tried Out on Speedway

NEW YORK CITY, April 26—The 300-cu. in Packard aviation engine is being tried out this week on Sheepshead Bay Speedway, it having been fitted to a specially built chassis of great engineering interest. The 2-mile wood track is not yet dry from the recent rains, so that it has not been possible to make any laps at full speed, as it has been thought unsafe to go to the top of the banking. On complete laps the car has been doing well over 100 m.p.h. and on the straightaways 116 m.p.h. is readily attainable. This is not official timing but is conservative checking with the stopwatch.

The engine has twelve cylinders 2 21/32 by 4½ in., giving just a trifle under 300 cu. in. piston displacement, and the gearing gives a crankshaft speed round about 3000 r.p.m. at 100 m.p.h. There are four valves per cylinder line. For these shafts, there is a gear drive Peugeot fashion, only this is arranged at the flywheel end instead of in front. An especially striking feature is the use of Delco ignition with a storage battery and a small Bijur generator; there is no magneto.

J. G. Vincent, vice-president, and Ralph de Palma have been driving the car in these preliminary trials. It is understood that the car is shortly to return to Detroit for examination and may be back on the speedway in a few weeks.

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Steenstrup Sails April 29

DETROIT, MICH., April 24—Peter S. Steenstrup, foreign representative of the Hupp Motor Corp., this city, will leave April 29 for Russia, Italy and other foreign countries in the interest of the Hupp organization. He will establish headquarters in London.

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Electric-Vehicle Program Out

NEW YORK CITY, April 26—The first session of The National Electric Light Assn. convention in Chicago devoted to electric vehicle interests will take place May 24, and will include the following program:

Chairman's address by Walter H. Johnson, secretary's report by A. Jackson Marshall, treasurer's report by H. M. Edwards, reports of section activities, and the committee reports as follows:

Membership committee, Joseph D. Israel, chairman; Standardization committee, E. R. Whitney, chairman; Motion Picture Film committee, Carl H. Reed, chairman; Traffic and Good Roads committee, A. H. Manwaring, chairman; Insurance committee, Day Baker, chairman. Appointment of Nominating committee.

The Thursday morning session will be devoted to the following committee reports and papers:

Garage and Rates committee, George B. Foster, chairman; Legislation committee, P. D. Wagoner, chairman; Federal and Municipal Transportation committee, J. H. McGraw, chairman; Industrial Truck Applications, by C. W. Squires, Jr.; Electric Truck Troubles and How to Eliminate Them, by F. E. Whitney; The Relation of Tires to Electric Vehicle Efficiency, by S. V. Norton; Greater Garage Service, by Harry Salvat.

Reports and papers for the last session, Thursday afternoon, are:

Operating Records committee, W. P. Kennedy, chairman; Central Station Cooperation committee, E. S. Mansfield, chairman; Exchange Battery Systems, by P. D. Wagoner; Passenger Vehicle Problems and Activities, by E. P. Chalfant; Central Station Promotion of Electric Vehicle Use, by W. P. Kennedy. Report of Nominating committee.

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Goodyear Issues $10,000,000 Preferred—To Increase Output

AKRON, OHIO, April 22—To take care of increased production and factory enlargements, the Goodyear Tire & Rubber Co., this city, has announced the sale of $10,000,000 of new preferred stock. The new facilities will make way for a much greater cord tire production than heretofore. The company has been working day and night for the past year and has been making factory enlargements for some time past to take care of increased business. But these additions have not kept up with the business growth and as a result the company expects to practically double its production facilities within the next ten months. The company has been turning out practically 17,000 tires a day. Within the year its capacity will be 25,000 tires a day.

The new cumulative preferred stock yields 7 per cent. A syndicate of bankers, composed of Kissel, Kinnicutt & Co., of New York City; Borton & Borton of Cleveland, and others, have taken over the stock for sale. The company agrees to set aside each year a sinking fund sufficient in amount to retire the issue at 112 within about twenty-three years and, in addition, to at all times maintain its net quick and total assets at not less than 115 per cent and 200 per cent, respectively, of the preferred stock outstanding. The financial strength of the company is indicated by the fact that the net quick assets, after this sale, amount to 154 per cent on the preferred.

The stockholders of the company will meet May 20 to adjust and increase its capital. The present outstanding issue of preferred amounting to $6,200,000 is to be called for redemption at $120 a share and will be replaced by a new issue of $17,700,000. Common shareholders are to receive a stock dividend of 100 per cent, bringing the outstanding common issue up to $17,500,000. Preferred stockholders will have the alternative of accepting $120 a share cash or the new preferred stock at $105 a share.

Niles Co. To Build Trucks

Railroad Car Maker's Line Will Comprise ¾ to 1-Ton and 2 to 2½-Ton

NILES, OHIO, April 21.—The Niles Car & Mfg. Co., this city, will shortly enter the commercial vehicle field with two models, one designed to carry from ¾ to 1 ton and the other from 2 to 2½ tons.

The two models will be along the same general lines, having the motor under the bonnet, with approximately an 85-per cent live load on the rear axle. The light truck will be equipped with pneumatic tires on demountable rims while the heavy truck will have solid tires.

Both models will be worm driven, the Timken David-Brown worm being employed. The front axle is Timken. On both models standard units will be three-point suspended Continental motor; Borg & Beck dry plate disk clutch; Stromberg carbureter; Fedder's honeycomb radiator; Blood Bros. universal joints with tubular driveshaft; and heavy artillery type wood wheels. Frames are pressed steel with heavy angle and reinforced with cross members and gusset plates. All bodies will be built by the company.

The Niles company, which has been manufacturing interurban electric and other types of passenger railway cars for over 15 years, will operate a large plant in Niles for the manufacture of the trucks. Special machinery is being installed at present.

Service stations will be opened and maintained in all the more important cities where the company's sales will be concentrated. The sales policy will be the direct-to-user plan, no agents or dealers being appointed.

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Warner and Patterson Buy Double Lens Company

CHICAGO, ILL., April 26.—A. P. Warner, formerly with the Stewart-Warner Speedometer Corp. and E. C. Patterson of *Collier's* have purchased the double Lens Co., making double lens non-glaring headlight glass. The new concern will be called the Warner Lens Co. and the product will be known as Warner Glass lens. In the new concern will be J. H. Cattell, formerly with the *Scientific American*. Warner and Cattell will be the active figures in the concern.

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Bruske with Mop Co.

DETROIT, MICH., April 21—Paul Hale Bruske, formerly director of publicity, Maxwell Motor Co., has become advertising manager of the O-SO-EZY Mop. Co., Detroit.

American Plant for Plainfield

Corp. Recently Formed Plans 3000 Five-Passenger Sixes in Year

NEW YORK CITY, April 22—The American Motors Corp., recently formed by Louis Chevrolet and a group of Eastern business men, has practically completed negotiations for the establishment of a plant in Plainfield, N. J. Production is expected to start by the middle of July and the corporation will turn out about 3000 cars the first year.

A five-passenger six-cylinder car selling under $1,000 has been planned as the first model. A Continental 3¼ by 4½-in. motor will be used. Other features include spiral-bevel drive, 122-in. wheelbase, 32 by 4-in. tires, self-starter and electric lighting.

A considerable part of the capital has been paid in. The company is capitalized at $1,250,000 and at the present time has $500,000 preferred and $500,000 common outstanding.

Louis Chevrolet will be chief engineer of the corporation. W. H. Hoople, president of the Interstate Electric Corp.; J. C. Spiers, formerly general manager of the Autocar Co. and factory manager of the Locomobile, Mercer, S.G.V. and Standard Roller Bearing companies, and G. F. Baright, formerly advertising manager of the Prudential Life Insurance Co., Newark, N. J., are backing the company.

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Develop Bournonville Rotary Valve Motors for Aeroplanes

NEW YORK CITY, April 26—Bournonville rotary valve motors are now being developed for aeroplane work by the Bournonville Motors Corp., this city. The work has proceeded far enough so that it is expected to have one of the motors on test at the A. C. A. about June 1.

In addition to the New York company, another has been formed in Canada, being incorporated in Toronto for $500,000. The incorporators are William Gilchrist, James Stewart and H. J. Stuart and others, all of Toronto. It is understood that the leading spirit in the Canadian enterprize is Col. J. B. Miller, head of the Polson Iron Works, Toronto. This concern builds the M.F.P. aeroplane.

For the time being, the automobile end of the business is understood to have been shelved and the company is pushing forward as fast as possible its work on the aeroplane motors, owing to the great demand for motors of this type. The motor which has been developed is expected to show from 160 to 180 hp. on the block test as 1600 to 1800 r.p.m.

The Bournonville motor was described in THE AUTOMOBILE for Dec. 24, 1914, on page 1156. It is a balanced rotary valve arrangement in which a single rotary valve is placed over the cylinders. The valve is made in separate pieces to avoid the complications due to longitudinal expansion. The arrangement of gas passage so that the gases act as a carbon sweeper is one of the features of the motor.

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Chevrolet Starts Building on $1,000,000 Additions

FLINT, MICH., April 22—The Chevrolet Motor Co. has begun several large additions to its plants here, these to cost between $750,000 and $1,000,000, and when completed it is stated the local Chevrolet organization will have a capacity of 350 cars per day, besides making it possible to turn out 1000 motors and 1000 axles each day, for distribution to the concern's several assembly plants in other sections of the country.

One of the new buildings will be an axle plant measuring 120 by 900 ft., all single story except 284 ft. at the front end, which will be two stories, to provide lunch rooms and other accommodations for the workmen. Another is a warehouse, 150 by 500 ft. and four stories high and additional assembly space is also to be provided in the form of a U-shaped structure with two 750-ft. wings three stories high. These buildings will all be of reinforced concrete factory construction.

As was recently announced, the Chevrolet organization has acquired manufacturing plants at Bay City, Mich., from the National Cycle & Mfg. Co. and the National Motor Truck Co. and this added capacity will be devoted to the making of some 200 motors a day.

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Hawkeye Is 1¼-Tonner

SIOUX CITY, IOWA, April 24—The Hawkeye Mfg. & Repair Co., this city, has brought out a 1¼-ton truck designated as model H. the chassis price of which is $1,250. A 36-hp., four-cylinder block-case valve in the head motor is used. This engine is made by the Hawkeye company. Other features are Stewart Warner vacuum feed, Eisemann magneto, three-speed gearset mounted in unit with the motor, multiple disk dry-plate clutch, semi-elliptic springs, etc.

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Puritan Buys Keeton Stock

DETROIT, MICH., April 25—The Puritan Machine Co., Detroit, Mich., recently purchased from the defunct Keeton Motors, Ltd., whose factory was located at Brantford, Ont., the stock of parts, blueprints, drawings, jigs, dies and tools, etc., and will continue service to Keeton car owners from the Puritan plant here.

Monroe in Welch Plant

Turns Over Flint Plant to General Motors—Durant Out of Monroe

DETROIT, MICH., April 24—The General Motors Co. has made a deal with the Monroe Motor Co., Flint, Mich., whereby the Monroe company turns over its factory at Flint to the larger organization and takes possession of the plants formerly occupied by the Welch Motor Car Co., Pontiac, Mich., now out of business. The plant at Flint adjoins the Buick factories and prior to its being occupied by the Monroe Motor Co. was used by the Chevrolet Motor Co.

The move seems to have been an advantageous one all around, because it allows the further expansion of the General Motors industrial organization at Flint, besides permitting the Monroe Motor Co. to concentrate its activities in Pontiac, where the Monroe Body Co., from which the Monroe car concern secures its bodies, is also located in Pontiac. It is expected that Monroe will make the move about May 15.

W. C. Durant, prominent figure in General Motors and Chevrolet activities, has severed his connection with the Monroe concern, of which he was formerly vice-president.

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United Motor Fuel Corp. Predicts Abundant Gasoline

NEW YORK CITY, April 26—The work of the United Motor Fuel Corp., in the interests of the automobile manufacturers during the last month, point to four conclusions, first, and most important, that the future has in store an abundant supply of motor fuel at prices lower than those prevailing; second, that no process now in common use does all that can be done in the production of gasoline; third, that no process except the Burton is as yet a demonstrated economical commercial success; fourth, that at least two processes now in their infancy will eventually develop into important factors in price reduction.

These deductions, according to the National Automobile Chamber of Commerce, are based on examination of all the well known processes and a number not so well known; of the probable supply of crude oil; of the possibility of using crudes now almost neglected as sources of gasoline supply, and on careful examination of all patents since the issue to C. H. Hall in 1869.

The United Motor Fuel Corp. has been flooded with all sorts of proposals, but is interested in nothing except processes demonstrated and in actual operation.

Iowa Buys 15,000 Cars in 1916

136,500 Registrations — Claim State in Third Place on March 31

DES MOINES, IOWA, April 25—Of the 136,500 cars already registered in Iowa for 1916, 15,000 are new machines, the records show. The oldest car thus far registered for this year is a 1903 Reo, and the next oldest is a 1905 Ford.

Iowa ranked third in the United States on March 31 in the number of automobiles registered for 1916, according to figures compiled by Roy Allen, head of the Iowa Automobile Registration Department. New York was first and California second.

Seven States registered over 100,000 cars in 1915. The number of cars registered in each up to April 1 of this year is shown in the following table:

State	Total, 1915	To April 1, 1916
New York	231,831	154,405
California	163,795	158,423
Iowa	145,109	136,500
Ohio	181,332	129,442
Illinois	180,832	120,447
Pennsylvania	159,984	115,408
Massachusetts	102,663	64,835

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Stanley Bros. Apply Steam Automobile Engine to Rail Use

NEWTON, MASS., April 22—F. E. & F. O. Stanley, the manufacturers of Stanley steam cars, are the principal figures in the Unit Railway Car Co. of Massachusetts just formed to make their steam motor applicable to railway cars. Those who have seen the new car that the Stanley brothers are building, and know what is planned, say that the passing of the electric trolley with its wires, expensive power stations and the huge steam locomotives with their coal and soot is not an impossibility in the near future. Kerosene will be used as fuel, giving five miles to the gallon.

For a long time the Stanley brothers have been working upon a plan of adapting to railroad and railway purposes the steam automobile engine which they have developed through a long series of years. They have now reached a point where the first car to be built will be ready for a trial trip in a little more than a month. When finished the new car will be given a trial on one of the railroads in New England.

The car will weigh much less than the ordinary railroad or trolley car of similar capacity, and it will cost much less to build.

The car now in process of construction will carry forty-four passengers and it has a baggage compartment and another one for the engineer. It will weigh about 35,000 lb. and will cost about $10,000. The car is adapted to interurban service or use on standard steam roads. It is to have a steel body, air brakes, electric lighting system and the standard railroad equipment required by the Inter State Commerce Commission. In addition to this car designs have been drawn up for a smaller car to carry twenty-six passengers.

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Material Prices Steady

NEW YORK CITY, April 25—Market prices last week were steady. With the exception of another 13-cent drop in lead and one of $2.50 in tin, prices were normal. Rubber prices are still being maintained at the low level established two weeks ago. The gasoline situation remains unchanged, no advances and no decreases having occurred. Since Louis Enricht of Farmingdale, L. I., made public the announcement of his new fuel, he has been swamped with reporters and cranks, but nothing further regarding the nature of the product has been divulged, nor have any more tests been permitted by the inventor.

Aluminum, copper, and open-hearth and Bessemer steels were steady and unchanged. Copper reached 29½ cents a pound last week with good sales. The aluminum market is easier with sellers lowering prices.

Oils and lubricants remained steady. Lard oil rose to 98 cents while cottonseed oil saw a 30-cent gain.

Daily Market Reports for the Past Week

Material	Tues.	Wed.	Thur.	Fri.	Sat.	Mon.	Week's Ch'ge
Aluminum	.58	.58	.58	.58	.58	.58	...
Antimony	.41½	.40	.40	.40	.40	.40	— .01½
Beams & Channels, 100 lb.	2.77	2.77	2.77	2.77	2.77	2.77	...
Bessemer Steel, ton	45.00	45.00	45.00	45.00	45.00	45.00	...
Copper, Elec., lb.	.29½	.29½	.29½	.29½	.29½	.29½	...
Copper, Lake, lb.	.29½	.29½	.29½	.29½	.29½	.29½	...
Cottonseed Oil, bbl.	10.50	10.60	10.65	10.65	10.65	10.80	+ .30
Fish Oil, Menhaden, Brown	.54	.54	.54	.54	.54	.54	...
Gasoline, Auto, bbl.	.24	.24	.24	.24	.24	.24	...
Lard Oil, prime	.96	.96	.98	.98	.98	.98	+ .02
Lead, 100 lb.	7.63	7.63	7.50	7.50	7.50	7.50	— .13
Linseed Oil	.76	.76	.76	.76	.76	.76	...
Open-Hearth Steel, ton	45.00	45.00	45.00	45.00	45.00	45.00	...
Petroleum, bbl., Kans., crude	1.55	1.55	1.55	1.55	1.55	1.55	...
Petroleum, bbl., Pa., crude	2.60	2.60	2.30	2.30	2.30	2.60	...
Rapeseed Oil, refined	1.05	1.05	1.05	1.05	1.05	1.05	...
Rubber, Fine Up-River, Para	.73	73	.73	.73	.73	.73	...
Rubber, Ceylon, First Latex	.83	.83	.82	.82	.82	.82	— .01
Sulphuric Acid, 60 Baume	2.00	2.00	2.00	2.00	2.00	2.00	...
Tin, 100 lb.	52.00	51.00	50.50	50.50	50.50	49.50	—2.50
Tire Scrap	.06½	.06½	.06½	.06½	.06½	.06	...

Cleveland S. A. E. Ranks Third

207 Attend Dinner and 250 Hear Carbureter Paper Following

CLEVELAND, OHIO, April 22—The Cleveland Section of the S. A. E. arranged a dinner at the Statler Hotel to mark the conclusion of the Standards Committee meeting held here yesterday, the dinner being followed by the paper on carburetion by F. H. and F. O. Ball, which is reprinted on page 762. A number of members of the Council were present. Mr. Ball read the paper from a small platform at the end of the large hall, the audience sitting at their tables. Before the paper was read a few short speeches were delivered from the chairman's table. Coker F. Clarkson, general manager of the S. A. E., spoke concerning the use of trucks by the United States Government, stating that the army found mechanical transport 30 per cent cheaper than animal. It is his conviction that the S. A. E. will take an important part in helping the military authorities to work out their plans for properly organized systems. Committees from the S. A. E. will be appointed to work with the army and give all the help possible.

J. H. Herron, chairman of the Cleveland section, said that the section had made rapid strides in membership, without much effort beyond that obtainable from an energetic membership committee. C. S. Pelton, secretary of the section, stated that the membership is now 171, being a gain of forty-five in one month. This puts the section third in membership and places it very close to that of the Metropolitan section. On June 24 there will be a field day, for which preparations are well advanced, and details of the entertainment program will be ready shortly.

The next meeting of the section will be on May 19, the paper for that occasion being entitled Efficiency in Automobile Practice, by A. Ludlow Clayden, chairman of the Standards Committee.

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353 Reservations for S. A. E. Cruise

DETROIT, April 24.—Reservations have been made to date for 353 S.A.E. members and friends for the summer cruise June 12—16. Treasurer W. H. Conant of the 1916 Meetings Committee reports daily receipts increasing, and it is now certain that the total accommodation of 550 on S.S. Noronic will be taken by June 1, if not earlier. At the present rate the ship will be sold out before that time.

Chairman Geo. H. Dunham had a full

meeting of his 1916 Meetings Committee in this city Saturday, and completed many plans for the cruise. For the benefit of those who want a day's fishing in Georgian Bay a complete outfit of fishing tackle will be carried on the Noronic and sold to members. The boat will stop at Sarnia, Ontario, on the return trip, Friday, June 16, for the convenience of those wanting to catch eastern trains at that point. This also applies to Grand Trunk trains west.

Attendance this year promises to eclipse all former years from the viewpoint of wide representation. Already nearly all of the past presidents have made reservations. The broad gage and high caliber papers that have already been arranged for have had much to do with many of the early decisions to go on the cruise.

In addition to the papers already announced the following have been definitely decided upon: W. H. Allen, Single vs. Dual Tires for Truck Wheels; A. P. Brush, High Speed Motors; Benjamin Liebowitz, Dynamics of Vehicle Suspension; H. L. Horning, Motors for Trucks and Tractors; A. J. Slade, Motor Truck Transport Preparations, and B. D. Bachman, truck subjects.

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Dividends Declared

Stewart-Warner Speedometer Co.: quarterly 1¾ per cent on preferred and 1½ per cent on common, both payable May 1 to stock of record April 22.

Splitdorf Electrical Co. will send out checks for an additional 7 per cent on account of dividends in arrears, leaving 12 per cent still unpaid.

Break in Security Prices

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Liquidation on Heavy Scale—Recovery on Favorable Report from Germany

NEW YORK CITY, April 25—The effect of unfavorable news or some national crisis on security prices was illustrated last Saturday when a violent break in stocks occurred, accompanied by liquidation on a heavy scale. The unfavorable tenor of Berlin advices at that time and the Mexican crisis overshadowed all other market considerations. One of the largest drops in automobile securities was that of General Motors, which declined 20 points. This stock and others, however, picked up substantially yesterday on intimation that Germany will endeavor to preserve peace with the United States.

Goodyear common was the only issue last week which showed strength. This stock rose to 405, or a gain of 35 points. The previous week it went up 34 points. This stock has been in great demand as a result of the coming stockholders' meeting, where it is said action will be taken on a 100 per cent stock dividend.

Chevrolet, Maxwell, Studebaker and Willys-Overland again dropped. Chevrolet, which declined 6 points the previous week, dropped 7 points on Saturday; Maxwell common, first preferred and second preferred showed net losses of 2⅝, 7⅝ and 4⅜ points; Studebaker common went down 18 points while its preferred dropped 4 points; and Willys-Overland common dropped 18 points after a 2-point drop the preceding week.

Tire issues which featured the market last week with substantial gains were a little lower. Goodrich common went down 3¼ points; Kelly-Springfield common dropped 4½ points; and U. S. Rubber common and preferred declined 2½ and 2 points, respectively.

Detroit quotations were in sympathy with those on the local exchange. Chalmers dropped 9 points; Continental Motor common declined 3 points; General Motors common 10 points and its preferred 3 points. Maxwell common and first preferred were 2 points lower while the second preferred dropped 1½ points. Studebaker common closed at 120, a decline of 14 points.

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Hurlburt Increases Capital $300,000 To Add Equipment

NEW YORK CITY, April 21—The need of more factory equipment to take care of its production facilities has caused the Hurlburt Motor Truck Co., this city, to increase its capital $300,000 from $150,000 to $450,000, of which $350,000 will be preferred stock paying dividends semi-annually beginning Oct. 1, 1916 at the rate of 7 per cent per annum. The balance, $100,000, will continue as common stock.

With the new equipment, the company expects to increase its present production materially. Production now ranges from 600 to 1000 cars a year.

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Stewart-Warner Retires Preferred

CHICAGO, ILL., April 21—The Stewart-Warner Speedometer Corp., this city, will retire at 110 and accrued dividends the $241,480 preferred stock, which is one-third of the amount outstanding.

Automobile Securities Quotations on the New York and Detroit Exchanges

	1915 Bid	1915 Asked	1916 Bid	1916 Asked	Wk's Ch'ge
Ajax Rubber Co. (new)	..	..	66	68	—1½
Aluminum Castings pfd	98	100	..	..	..
J. I. Case pfd	80	87	86	90	—1
Chalmers Motor Co. com	93	98	150	155	..
Chalmers Motor Co. pfd	92	94	97	99	..
Chevrolet Motor Co	..	..	178	182	—7
Electric Storage Battery Co	..	..	62	64	+2
Firestone Tire & Rubber Co. com	450	458	800	..	..
Firestone Tire & Rubber Co. pfd	110	112½	114	117	..
General Motors Co. com	144	146	400	420	—30
General Motors Co. pfd	99	101	111½	112½	—3½
B. F. Goodrich Co. com	47	48	73½	74	—3¼
B. F. Goodrich Co. pfd	101	102½	114	115	—1
Goodyear Tire & Rubber Co. com	237	240	405	440	+35
Goodyear Tire & Rubber Co. pfd	104	105	116	119	+2
Gray & Davis, Inc., pfd	..	..	..	..	..
International Motor Co. com	17½	19½	10	15	—3
International Motor Co. pfd	32	35	20	25	—5
Kelly-Springfield Tire Co. com	132	134	68	69	—4½
Kelly-Springfield Tire Co. 1st pfd	84	85	95	97	—1
Kelly-Springfield Tire Co. 2d pfd	130	140	..	..	..
Maxwell Motor Co. com	47	49	69½	70½	—2⅝
Maxwell Motor Co. 1st pfd	81½	83½	77	79	—7⅝
Maxwell Motor Co. 2d pfd	37	39	50	52	—4⅜
Miller Rubber Co. com	185	190	265	..	..
Miller Rubber Co. pfd	101	103	113½	114½	..
New Departure Mfg. Co. com	137	138	190	195	+9
New Departure Mfg. Co. pfd	106	110	112	..	+1
Packard Motor Car Co. com	86	..	165	175	..
Packard Motor Car Co. pfd	93	..	100	104	..
Paige-Detroit Motor Car	..	..	750	850	..
Peerless Motor & Truck Corp	..	..	20	24	—5½
Portage Rubber Co. com	34	36	75	77	..
Portage Rubber Co. pfd	85	95	108	109	..
Regal Motor Car Co. pfd	..	..	20	24	+2
*Reo Motor Truck Co	14½	16	28¼	29½	+ ¼
*Reo Motor Car Co	33	34	38	39	—1
Splitdorf Electric Co. pfd	..	..	..	..	..
Stewart-Warner Speed. Corp. com	68	69	84¾	85	—2¼
Stewart-Warner Speed. Corp. pfd	103	105	109	..	..
Studebaker Corp. com	65	67	120	123	—18
Studebaker Corp. pfd	100	102	108	111	—4
Swinehart Tire & Rubber Co	90	95	84	86	..
Texas Co.	137	139	179	181	—10
U. S. Rubber Co. com	68	69	50½	51	—2½
U. S. Rubber Co. pfd	106	108	106	108	—2
Vacuum Oil Co	209	212	230	235	—10
White Motor Co. (new)	..	..	49½	50½	+ ½
Willys-Overland Co. com	125	127	210	215	—18
Willys-Overland Co. pfd	100½	102	102½	103½	—1½

OFFICIAL QUOTATIONS OF THE DETROIT STOCK EXCHANGE

ACTIVE STOCKS

	1915 Bid	1915 Asked	1916 Bid	1916 Asked	Wk's Ch'ge
Auto Body Co	..	..	..	..	..
Chalmers Motor Co. com	..	95¼	..	155	—9
Chalmers Motor Co. pfd	93	96	96½	99	..
Continental Motor Co. com	175	190	34	35	—3
Continental Motor Co. pfd	80	85	..	10¼	..
Ford Motor Co. of Canada	600	..	385	405	..
General Motors Co. com	143	145	410	440	—10
General Motors Co. pfd	100	103	110	113	—3
Maxwell Motor Co. com	51	53	69¼	72	—2
Maxwell Motor Co. 1st pfd	82½	84½	80	84	—2
Maxwell Motor Co. 2d pfd	38½	40½	51	54½	—1½
Packard Motor Car Co. com	80	..	..	174	—1
Packard Motor Car Co. pfd	93¾	..	..	104	+ ½
Paige-Detroit Motor Car Co	..	..	..	850	..
*Reo Motor Car Co	32¾	33¾	38	39	— ¾
*Reo Motor Truck Co	14¼	15¼	..	28½	—1
Studebaker Corp. com	65½	67½	120	126	—14
Studebaker Corp. pfd	99	101	109	..	..

INACTIVE STOCKS

*Atlas Drop Forge Co	..	26	..	40	..
Kelsey Wheel Co	195	..	320	365	..
*W. K. Prudden Co	19¾	21	30	32½	— ½
Regal Motor Car Co. pfd	12	20	15	22	..

*Par value $10.

Automobile Industry Represents 28% of Capital in Detroit Manufacturing

U. S. Census Statistics for 1914 Show 120 Concerns Making Cars, Trucks, Bodies and Parts, Etc., Produce 40 Per Cent of Value of All Manufactures in That City

DETROIT, MICH., April 12—Some striking facts to indicate what the automobile industry has done for the city of Detroit are to be found in the statement just issued, which gives detailed statistics of the four leading industries of this city; namely, automobiles, copper, brass and bronze, slaughtering and meat packing, and tobacco. This covers the year 1914 and is supplementary to the preliminary report made some months ago, giving results for Detroit of the census of manufacturers for the calendar year of 1914.

That the automobile industry really constitutes a considerably larger proportion of Detroit's industrial wealth than has been supposed, is indicated by the figures which show that the amount invested in the industry here, including parts makers was 28 per cent of the total amount of money invested in all business enterprises of this city for 1914.

Automobiles and parts to a value of $163,588,000 were produced in the year, equal to 40 per cent of the $402,864,000 value of all manufactures. The industry paid for materials $101,259,000 out of $223,527,000 paid by all manufacturing trades, or 45 per cent, and added $62,329,000 to the value of the materials by manufacture.

The present statement shows that $82,561,000 of the total capital of $295,171,000 invested in manufacturing plants in Detroit, was invested in the automobile industry; $9,405,000 in copper, brass and bronze works; $4,121,000 in slaughter houses and meat packing, and $8,505,000 in tobacco works.

Of the city's total of 2030 manufacturing concerns in 1914, 120 were devoted to the automobile industry; forty-one to brass, bronze and copper works; thirteen to slaughtering and meat packing, and 1007 to the manufacture of tobacco, cigars, etc.

Each of thirty-one establishments produced automobiles, trucks or parts to the value of $1,000,000 and over, 30 to the value of $100,000 to $1,000,000 and 32 to the value of $20,000 to $100,000.

Of the 120,977 persons engaged in manufacturing, the automobile plants employed 37,641; brass, bronze and copper works, 4579; slaughter houses and meat packing, 1299, and tobacco concerns, 7832. Of the total number of persons engaged in manufacturing, 31 per cent are engaged in automobile work.

Of the total industry of the city, the automobile industry constitutes 28 per cent; the number of persons engaged in automobile work constitutes 31 per cent of the total number of persons engaged in manufacturing. Salaries in the automobile business are slightly under the average, as shown by the fact that the motor car industry constitutes 34 per cent of the aggregate salaries and wages and 25 per cent of the total paid in salaries, but the wages paid to the automobile workers constitute 37 per cent of the city's total paid in wages in the manufacturing industries.

Cost of material, value of products and value added by manufacture for the four industries appear in the tabulation.

Industry	Cost of Material	Value of Product	Value Added by Manufacture
Automobile	$101,259,000	$163,588,000	$62,329,000
Brass, copper and bronze	10,442,000	15,159,000	4,717,000
Slaughtering and meat packing	18,489,000	20,321,000	1,832,000
Tobacco	7,309,000	17,044,000	9,735,000

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Harkness to Try for World's Record in Blitzen Benz

NEW YORK CITY, April 24—H. S. Harkness has bought the Blitzen Benz in which the late Bob Burman established the world's record in 1911 at Daytona, Fla., when he drove 1 mile in 25.4 sec. The car was formerly owned by S. A. Fletcher, an Indianapolis banker. This car will be driven at the Sheepshead Bay Speedway on May 13 in an attempt to lower the present mark made by Burman at Daytona. Though no driver has as yet been selected for the trial, it is stated that Mr. Harkness will in all probability be its pilot.

—

Premier Racing Motor Develops 140 Hp. at 2900 R.p.m.

INDIANAPOLIS, IND., April 24—The Premier Motor Corp. is building two or three racing cars which will have four-cylinder 3⅝ by 6⅝-in. motors, developing 140 hp. at 2900 r.p.m. Practically the entire steel work is of chrome vanadium steel.

The motor, an overhead-valve type with two intake and two exhaust valves in each cylinder, has its camshafts driven by a train of gears which extend up the front. Each gear is carried on two annular ball bearings. The crankshaft is made from special steel and is carried on four annular ball bearings.

Castor oil is used exclusively and is carried under air pressure from the tank to sight feeds located on the dash from whence it passes through separate leads to each of the crankshaft bearings and to both camshafts, which are hollow. The oil passes through them the full length of the motor and overflows at the front and on the train of gears. The oil which goes to the crankshaft bearings passes through the ball bearings and after it is thrown off by them it is kept in banjo-shaped rings which are fastened to the side of the crankshaft. After the oil gets into these banjo rings it is thrown by centrifugal force and carried into the crankpins where it lubricates the big end of the connecting-rod and then is carried up on the connecting-rod through a small tube to the piston pin.

The rear springs are semi-elliptic, 50-in. long and absorb both the torque and the drive of the car. The front springs are semi-elliptic and are bound with cord for part of their length. Double shock absorbers are attached to each spring. Several different rear axle lever gear sets were tried and the results noted. The final ratio selected was 3 to 1, using a 35-in. tire.

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Empire to Try for West-to-East Record

NEW YORK CITY, April 24—An attempt will be made by the Empire Automobile Co., Indianapolis, to break the West-to-East record of 11 days, 5 hr., 25 min. made by E. G. Baker and W. F. Sturm last May in a Stutz. An Empire car will be shipped to San Francisco today from this city in charge of Robert Hammond, who will drive it from that city. He expects to make the trip in ten days. He will be accompanied by M. Smith, a newspaper man.

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Racklyft Joins Sunderman Carburetor

NEW YORK CITY, April 21—J. W. Racklyft, former assistant chief engineer of the Northway Motor & Mfg. Co., Detroit, Mich., has been appointed assistant chief engineer of the Sunderman Corp., this city, and will assist Capt. F. R. Sunderman, chief engineer of the company, in conducting tests for Detroit and Middle Western manufacturers.

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Plummer Forms Liberty Agency

NEW YORK CITY, April 20.—J. F. Plummer, for sixteen years local manager of the Locomobile Co. of America branch, has organized the Colonial Motors, Ltd., which will handle the Liberty car.

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Splitdorf Gets Hupp Export Contract

NEWARK, N. J., April 20—The Splitdorf Electrical Co., this city, has closed a contract with the Hupp Motor Car Corp., Detroit, Mich., for its magneto requirements for 1917 on all cars for export. The Dixie 40 will be used.

21 Sheepshead Bay Entries

Nine Are of Foreign Make—Full List of 32 Expected

NEW YORK CITY, April 25—Twenty-one entries to date have been made for the Sheepshead Bay Speedway races on May 13. The latest entrant is Joseph Christiaens, the Belgian, who drove the six-cylinder Excelsior into sixth place at Indianapolis two years ago. He has just arrived in this city from London and has brought over a new Sunbeam Six.

To date nine foreign entries have been made for the four events on May 13. These events include the Metropolitan Trophy, 150 miles; Queens Cup, 50 miles; Coney Island Cup, 20 miles; and a 10-mile handicap, for non-winners, called the William E. Kemble Cup.

France will be represented by four Delages and three Peugeots, while England will be represented by two Sunbeam sixes.

Cars and drivers entered to date are:

Car	Driver
Erwin Forty	Grover C. Bergdoll
Erwin Forty	Eugene Stecher
Peugeot	Ralph Mulford
Crawford	Billy Chandler
Crawford	Dave Lewis
Crawford	Unnamed
Duesenberg	Eddie O'Donnell
Duesenberg	C. J. Devlin
Maxwell	Pete Henderson
Maxwell	E. C. Rickenbacher
Peugeot	Dario Resta
Peugeot	John Aitken
Delage	Carl Limberg
Delage	Jack Lecain
Delage	Unnamed
Delage	Unnamed
Sunbeam Six	Joseph Christiaens
Sunbeam Six	Aldo Franchi
Mulford Special	W. T. Muller
Olsen	C. W. Thompson
J. J. R. Special	Bert Watson

Resta will race against Aviator De Lloyd Thompson in an exhibition event May 6 and 7.

Three Meets for Tacoma

TACOMA, WASH., April 11—The Tacoma Speedway Assn. has definitely decided on three meets for this season, the dates being Decoration Day, July 4 and Aug. 5. The events for the Decoration Day program include three races of 10, 20 and 30 miles. There will also be an outdoor motor car show and a large parade of cars. The prizes for the day total $500 besides accessory prizes.

A New Kerosene Vaporizer

Ohio Gas Generator Co. Will Manufacture Webber Patent Device

COLUMBUS, OHIO, April 22—The Ohio Gas Generator Co. has been formed here to manufacture a kerosene vaporizing device patented by Theodore Webber, formerly of Buffalo, who has been in this city for the past three years rfecting his invention. This consists of a cylindrical container which is placed around the exhaust pipe of the engine; kerosene is passed through this and the heat of the exhaust vaporizes it so that on being mixed with air the gas is highly explosive. Webber also has an attachment which injects a small quantity of water into the cylinder at each revolution of the engine.

Mr. Webber recently gave a demonstration of his vaporizer attached to a 5-hp. stationary gasoline engine which ran 6 hr. on 3 gal. of kerosene.

S. A. E. Standards Considered in Cleveland

(*Continued from page* 782)

motor and ignition standards; and the collection of data on flexible metallic tubing with a view to early standardization.

A. L. Riker, chairman of the division, reported that the sub-committees were at work. The lamp committee intends to make a scientific investigation of the glare question, to standardize some small parts like lamp glasses, and to take up any other work along this line. The other sub-committee is a joint one, having representatives from the Engine and Transmission division, and it seems probable that the lighting generator will be the first point of attack. The variations in practice are so large that it is obviously going to be a serious undertaking to set up standards which will be suitable to all requirements. Probably a good deal of original work will have to be done, but it is felt that the situation is in a plastic state and ought, therefore, to yield to standardization without great difficulty.

The division made some minor recommendations for the revision of the sheets of the data book dealing with grounded return wires. They also recommended that lamps for three-cell batteries should in future be known as 7-volt bulbs and those for six-cell batteries as 14-volt bulbs; the gage of the metal also to be removed from the bulb base specification. These recommendations, together with the rest of the report were accepted unanimously.

Sheet Steel Next Development

The Iron and Steel division had a progress report which K. W. Zimmerschied, chairman, presented. At present sheet steel has no proper classification, its specification for chemical and physical qualities, the nature of the finish and the gage of metal are somewhat obscured by the use of such names as "fender stock," "panel stock," etc. Mr. Zimmerschied said it was anticipated that the work would occupy a year or two.

It was reported that the division found it impossible to recommend any standard system of coloring for steel bar stock to distinguish the brands. The best color system depends upon the grades carried in stock by a manufacturer. A new steel of 40-50 carbon, 3½ per cent nickel will be recommended as an addition to the S. A. E. steels, this being specially suitable for oil tempered gears. Some alterations in test specimen specifications are being considered.

To Standardize Truck Control

W. P. Kennedy, chairman Truck Standards division, reported that the solid tire questions before his division were still active issues, the question of proper loading for the different sections now being under consideration. The chief work before the division is now the standardization of truck controls so that a driver will be able to change from one to another without any feeling of strangeness. Position of gear lever, location of pedals, of brake lever, etc., will be considered, together with such detail as the direction of throttle lever movement, etc. J. Younger, Pierce-Arrow Motor Car Co., made a strong plea for a fundamental consideration of this subject, urging that the division make experiments to discover what is best, and do not pay too much attention to prevailing practice. This view was well supported by the meeting, and the remark was made that there had already been considerable trouble in the Mexican expedition through drivers having to take over trucks which were strange to them. There has been endless trouble in Europe on this account.

Roller Bearings in Metric Size

The Carbureter Fittings division report was presented by V. R. Heftler, Zenith Carbureter Co. It contained recommendations regarding certain sizes of double outlet carbureters and described the work being done with throttle lever throw and gasoline pipes.

The Ball and Roller Bearings division, presented a sheet of proposed dimensions for metric sizes of taper roller bearings which would interchange with standard sizes of ball bearings, and also reported

progress with respect to ball thrust bearings. The taper roller bearing recommendations will be circulated and re-submitted at the June meeting.

Professor Fishleigh, in presenting the report of the Engine and Transmission division announced that progress was being made with revision of the S. A. E. engine test forms and determinations of engine characteristic curves. The division has asked for a number of tests to be made on V belts, and the chairman of the Standards Commttiee, A. Ludlow Clayden announced that he had asked Cornell University to undertake the tests. The mechanical engineering department of the University had expressed its willingness to accept the responsibility.

The Spring, Electric Vehicle, Nomenclature and Chain divisions also presented short progress reports describing the work in hand. Mr. Zimmerschied said that the nomenclature compilation was nearing completion, and it was hoped to finish it before the summer meeting took place.

Fuel Economy Test

Hereunder follow the main provisions of the fuel economy test recommended by the Research division which has been accepted as far as it goes, with instructions to the division to proceed with consideration of an ability formula and an acceleration test:

1—The test shall be conducted on an automobile speedway.

2—The fuel consumption shall be measured at a series of speeds varying from 10 miles to the maximum speed of which the car is capable.

At each speed a distance of 10 miles shall be covered and to eliminate the effects of variable wind resistance two runs must be made at each speed in opposite directions around the speedway. The following table shows the order in which the runs must be made and the speeds at which they must be made together, with the approximate time consumed.

	M.P.H.	Dist.	Time hr.	Min.
1st run	10	10	1	
Reversed direction	10	10	1	
2nd run	15	10		40
Reversed direction	15	10		40
3rd run	20	10		30
Reversed direction	20	10		30
4th run	25	10		24
Reversed direction	25	10		24
5th run	30	10		20
Reversed direction	30	10		20
6th run	40	10		15
Reversed direction	40	10		15
7th run	50	10		12
Reversed direction	50	10		12
Etc. to limit of speed				
	140		6	42

3—Fuel shall be fed to the carbureter during the test by gravity and shall be supplied from a special tank mounted so that the vertical distance between the top of the float chamber of the carbureter and the bottom of the fuel chamber is not less than 12 in. There shall be two tanks, preferably mounted side by side. These tanks shall be so connected to the main fuel pipe (by means of two cocks or otherwise), that one tank may be cut in and the other cut out in a fraction of a second. Of these two tanks one is a reserve tank used for maneuvering between test runs and this may be a fixture if so desired. The other tank which will be used during the test must be capable of easy detachment so that it can be weighed and replaced without difficulty. The tank used for the tests must contain sufficient fuel to enable the car to complete its run at the maximum speed on one filling.

4—The method of controlling the fuel shall be as follows: The engine must previously be brought to a condition of normal temperature. The special tank shall have been filled with fuel and weighed carefully. It is suggested that this may readily be done on a carefully calibrated spring balance. The tank shall then be connected so that it can be brought into use by the observer sitting beside the driver. The speed at which the test is to be made shall first be obtained from the reserve tank and the special tank shall be switched in by the observer on crossing the starting line marked on the speedway.

5—The speed during each run must be maintained as constant as possible. The time for each lap is to be checked by the observer and in no case must it deviate from the scheduled time by more than five per cent, plus or minus.

6—On the completion of each stage of the test it shall be repeated in the opposite direction every condition being observed as before.

7—At the conclusion of each stage of the test the special fuel tank shall be removed from its attachment and again carefully weighed. The weight of fuel consumed having been entered, the tank may be refilled and weighed again previous to the commencement of the succeeding stage.

8—The whole of the fuel to be employed during the entire test must be retained in a receptacle from which the observer can take a sample for the purpose of checking the specific gravity whence the quantity of fuel employed during the test may be determined from the weights actually measured.

Note: The object of specifying measurement of the fuel by weight instead of by volume is that the accurate measurement of the weight of the tank can easily be made from time to time as required, whereas the accurate measurement of volume calls for more elaborate apparatus and is much more susceptible to error.

9—The entire cooling system of the automobile must be fully operative during the test both as regards air and water circulation.

10—Coasting or declutching is not to be permitted.

11—The entire test is to be made in the highest gear, this including the final acceleration test.

12—The test is to be run with the car in the condition as indicated on the form, that is with all tanks full and full complement of passengers or corresponding ballast.

13—Oils or greases used in the engine, transmission, rear axle or other parts of the car must be of normal quantity and quality.

14—The car must carry its full standard equipment of parts and accessories, which must be the stock accessories as supplied by the manufacturer in accordance with the A. A. A. definition.

15—The test should be certified by a competent and impartial observer having no financial or commercial interest in the results. This observer shall make affidavit before a notary public regarding results of the test and the latter shall affix his seal to the report.

16—Immediately upon conclusion of the fuel economy tests an acceleration test must be made in accordance with the S. A. E. form. This test must be made with the same carbureter adjustment as that used for the fuel consumption tests.

17—From the commencement of the economy test to the conclusion of the acceleration test there must be no manipulation of any carbureter adjustment or control other than the throttle.

Explanatory Notes and Definitions

Weight of car alone—By this is meant the weight of the car with all oil, fuel and water tanks full, including special equipment necessary for the test and full standard equipment of tools, tires, rims, spare wheels, etc., as supplied with the stock model of the car.

Full complement of passengers consists of one passenger or the equivalent for each seat provided, driver included. The average weight for passengers and driver to be 150 lb. each.

For inclosed bodies all windows and doors to be closed. For touring bodies, top to be up, side curtains not used and rear curtain to be fastened down.

Windshield to be fully erected during test.

The pressure in the tires shall be that recommended by the manufacturer of the tires used, corresponding to the load applied both front and rear.

Information must be furnished in the form of a Baumé gravity reading for the fuel and supplemented wherever possible by a curve showing the results of a distillation and heat value tests. The trade name of the fuel used must be given.

Wind velocity—The fact is emphasized that the test should be run at a time when no appreciable wind exists.

The Four-Cylinder Motor of To-Day

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pression pressures, while the brake mean effective varies as the mechanical efficiency, which according to good practice ranges between 20 to 30 per cent above compression pressures.

The matter of power impulse per revolutions, or torque quality, is not as new a subject as the road vehicle as we know it to-day. Many years of steam practice combined with that of the internal combustion motor have established the fact, that so far as working ability is concerned, an impulse stroke every 180 deg., or two per revolution, multiplied by the available number per minute, produces an almost perfect power flow.

How the Motor Works Out

Having outlined the factor values as we know them to-day let us consider a motor using the limits specified which are not extreme by any means.

P representing the m.e.p., we can assume as actual at 120 lb., L representing length of stroke in feet has a value of 0.5, A or area of piston equals 7.06 while N or number of power impulses per minute we have as 6000. Expressed by the usual formula we have $\frac{120 \times 0.5 \times 7.06 \times 6000}{33{,}000} = 77$ hp., a truly remarkable performance when we consider that such a motor complete should weigh about 400 lb.

This motor applied to the road should be geared about four to one with a third speed reduction of 1.33 to 1; second speed 2 to 1, and first 3 to 1, making the motor to wheel gearing 4-5.33-8 and 12 to 1 respectively, using 34-in. wheels, road speeds from 8 to 65 m.p.h. could be had on direct drive, while third speed would afford a possible range from 4 to 70 m.p.h.

The high m.e.p. obtained would not permit a wide open throttle at very low speeds with any spark advance, as very objectionable and detrimental pounding would result. To safeguard against this abuse a purely mechanical carbureter should be employed, with dimensions such as would prohibit a wide open condition at low engine speeds.

If greater car speeds are desired especially for the heavier type of vehicle, more power is easily had by changing the bore to stroke ratio, and still keep within the limits of our m.e.p. and piston speeds. This would, however, result in a slight loss of thermal efficiency.

Constructional features are matters of individual tastes. To obtain, however, the efficiency outlined, neutral space must be kept to a minimum which excludes practically all valve types other than over head or sliding sleeves. Intake gas speeds should be kept below 12,000 ft. per minute, and reciprocating parts must be extremely light.

The practice outlined is beyond the conventional, but has been demonstrated as easily possible many times. Except for the one extremely low factor, that of the thermal efficiency, it represents an ideal easily obtainable.

In comparison to motors with a greater number of cylinders of the same displacement, the answer lies in the question of thermal efficiency. The heat losses represent practically 60 per cent of the total fuel used, and are about equally divided between the flow to the cooling medium and the exhaust losses. The cooling medium losses are in proportion to the surface exposed, times the heat gradient, since the surface exposed increases rapidly in relation to the displacement as volumes are divided. The heat losses are likewise increased; in addition the mechanical losses, while small increase in exact proportion to the number of cylinders added.

Considering that thermal efficiency is the only point that prohibits perfect realization of the Otto cycle theory, anything that tends to decrease the possibilities should be considered a step backward. The demand, however, for power output beyond the possibilities of a four-cylinder motor as outlined must be met by the use of a greater number of cylinders in proportion to the power needed.

Theory Favors Four Cylinders

Discussion of Four-Cylinder Papers Points to Greater Thermal Efficiency of Four—Higher Mean Effective Pressures Urged at Reduced Throttle Openings

OWING to the presence of a number of members of the Society of Mechanical Engineers and the Aeronautical Society, the discussion on these papers very often went over to stationary and aeronautical practice. Some of the comments from the aeronautical point of view were particularly interesting in showing that the cylinder question is not confined to automobile design.

President Barker of the Aeronautical Society called attention to the fact that in Mr. Watts' paper the ultra-multi-cylinder engine is referred to as the de luxe type. "I wish to call the attention of the assembled engineers," said Mr. Barker, "to the fact that the aeroplane motor must be an ultra-multi-cylinder design. Therefore it is the motor de luxe-that should require and should have the particular attention of engineers in its development. There seems to be nothing to criticise in Mr. Watts' paper, but it is necessary to look ahead. The development in the automobile engine has reached a very high point. It has become difficult to criticise. Now there are other worlds to conquer. Entering the aerial field you will find ample material for the wonderful ability and skill which has been developed in the past twenty years in the profound study that has been made of the automobile motor. If you automobile engineers will turn your attention to the aeroplane motor you will find there the full opportunity to develop."

Four Cylinders for Aeroplanes

Hugo Gibson, president of the Coalition Co., took exception to Mr. Barker's contention that the ultra-multi-cylinder engine is necessary for aeronautical purposes. He said:

"Since economy is perhaps the prime necessity in aeroplane engines after power, of course, then necessarily the fewer the cylinders the better for the proposition. So with the greater number of cylinders are you not confusing the advantages of smoothness, absence of vibration, etc., with the necessity for economy and large amount of power from a small amount of weight? These are the real necessities in aeronautical matters, and if that is so then we have nearly gone the limit if Mr. Watts' paper is right: that the limit of any cylinder is 4½ in. in diameter. I disagree with Mr. Watts in this point, however."

E. Favary, president of the Favary Tire & Cushion Co., stated that in listening to the papers one is forced to the conclusion that the four-cylinder engines should be in universal use, but while we all agree that the four-cylinder engine is most efficient and that the engines with a higher number of cylinders are not always attuned where they will show up to advantage, still they are here and they are gaining ground.

Mr. Favary went on to say: "Both papers presented this evening show us that the four-cylinder engine has a much higher thermal efficiency and is, therefore, the engine which should be most extensively used in the future. This is no doubt true, but at the same time we all admit that an engine with a greater number of cylinders has a more uniform torque and a more perfect running balance; it allows driving at low speeds without jerks and obviates the necessity for such frequent gear changes. These points, of course, are most important to the automobile user. All vibrations I believe can better be decreased in engines of a larger number of cylinders than in four-cylinder engines. On account of the increased cost of fuel, and the more extensive uses to which the automobile is adapted, economy plays a most important part, and therefore the greatest field for the future, as Mr. Porter pointed out, is to increase the thermal efficiency.

Heat Losses Enormous

"We all know that the heat losses are enormous. For this reason it is of prime importance to find some means for their reduction. The greater the number of cylinders, the greater the jacket area exposed to the hot gases, and the greater are those losses. For instance, a six-cylinder has approximately 20 per cent more area exposed to the cooling water than a four-cylinder engine, and in practice it means somewhere between 10 per cent more fuel. However, even in a four-cylinder, the losses are enormous, and I want to point out some means which might in the future prove a basis for development.

"Since piston speeds are now practical at 3000 ft. per minute, where some years ago 1000 ft. per minute was considered the limit, I think the combustion chamber could be kept at a much higher temperature without danger of pre-ignition. In other words, on account of the high speed of the engine, ignition would not take place before the charge should be fired, knowing that it does take some time after firing before obtaining the full effect of combustion. For this reason, a much higher temperature might be permissible. At the same time we must remember that oil will carbonize at higher temperatures, which would render its lubricating qualities defective and the running of the engine impractical. A possible field of development might be to provide only the part of the cylinder below the combustion chamber with a water jacket, so as to cool the portion requiring lubrication, while at the same time allowing the combustion chamber to have a higher temperature. If desired, the cylinder head may be bolted to the cylinder by the interposition of asbestos packing or some other non-conductor. To get the best results the piston rings should be lower down on the piston so as to increase the cubic content of the cylinder which can be maintained at a higher temperature. The possibility, perhaps Utopian, of still further reducing the temperature of the combustion chamber wall, might be accomplished by lining it with some material substantially impervious to heat. Of course we must bear in mind the occurrence of pre-ignition, but some means might be found for overcoming this.

Outside Compression Possible

"A higher engine speed, as previously mentioned, would greatly assist to overcome pre-ignition. In order to keep the mixture cool, it might be found advantageous to compress it outside the cylinder, and admit it through large valves into the cylinder, after the piston has completed a portion of the suction stroke. The mixture, at a low temperature, entering the cylinder under compression, requires some time before reaching the temperature of spontaneous ignition.

"Furthermore, by forcing the compressed mixture into the cylinder at a certain position of the suction stroke, the gas will expand, thereby tending to lower the temperature of the mixture. On the compression stroke, of course, the temperature will again be raised. This, with the increased engine speed, may render it possible to have the combustion chamber wall at a very much higher temperature, thereby obtaining an increased thermal efficiency."

J. Edward Schipper, technical editor THE AUTOMOBILE, advanced the idea that the matter might be one of piston displacement per cylinder, saying: "In the matter of cylinders it sometimes seems to come down to almost a point of piston displacement per cylinder. The consideration of what are the best working stresses on main bearings and connecting-rod bearings seems to be an important factor that has a good deal of bearing on the number of cylinders. Taking many of the present-day automobile engines that have worked out satisfactorily, it seems as if a piston displacement of about 70 cu. in. per cylinder seems to hit the nail pretty squarely on the head; and Mr. Watts has in his paper classified cars according to the weight. That seems to bear out this way of looking at it also. That is, the four-cylinder engine running less than 300 cu. in. piston displacement seems to correspond to about 70 cu. in. per cylinder, giving an easy working engine as far as bearing surfaces are concerned and also one in which the advantages of good carburetion obtain.

"For cars in what he calls the luxurious class—and he says there that the multi-cylinder engine might be justified—if we take the piston displacement which would be obtained by using say 70 cu. in. to the cylinder that would probably run it rather high. But nevertheless it seems that the piston displacement per cylinder is the limiting factor, which might be one of the methods of determining the correct number of cylinders to use for any given weight of vehicle."

Porter Closes Discussion

In closing the discussion, Mr. Porter said, in part: "Displacement per cylinder, as suggested by Mr. Schipper, I think, is on the right road, but I think it is a little bit under what is the limit, but it is well within what is necessary. I do not believe that there is any automobile built or any condition of automobiling in the world outside of racing that can need more than 300 cu. in. Because out of such a motor you can get 100 hp. without half trying, and it would work well, and you would never have occasion to use that horsepower. The average automobile does not need it: At something like 40 m.p.h. I think the five-passenger, 2000 to 3000-lb. car, takes about 20 hp. at 50 m.p.h.

"Now when it comes to acceleration, your road wheels govern that. It is the amount of traction you give. You can spin your wheels just as fast as you want to. Not more than 300 cu. in. or about 70 cu. in. per cylinder is absolutely all you want unless you have some other condition. The car I spoke of has more than that; it has 450; and I would not trade it for anything. If I get rid of that I guess I will quit. But it is simply because there seems to be no limit to what it can do. It can go to 100 m.p.h. or go up any hill in the world, accelerate as fast as 2500 r.p.m., but it has a great deal more power than is needed."

Factory Miscellany

Erlin Co. to Build—The Safety Auto Light and Mfg. Co., Erlin, Ohio, will build a plant.

Plant for Piedmont—The Piedmont Motor Co., Lynchburg, Va., contemplates building a plant.

Imperial Motor to Build—The Imperial Motor Co., Ottawa, Ont., will build an addition to its factory. L. H. Roy is manager.

Ford Building for Salt Lake City—The Ford Motor Co., Detroit, is planning the construction of an assemblying plant at Salt Lake City, Utah. The estimated cost is $400,000.

White Springs Tire Plant in Edmond—A tire plant will be equipped by the White Springs Tire Co., Edmond, Okla., recently formed with a capital of $50,000. J. W. White and M. J. O'Connor are interested.

Simplex Starter Adds—The Simplex Starter Co., Anderson, Ind., will make another addition. The new unit will enable the company to turn out 100 additional starters a day, which is double the present capacity.

Canadian Plant for Perfection Tire—The Perfection Tire & Motor Co., Fort Madison, Iowa, has had plans prepared for a Canadian branch plant to be erected at Niagara Falls, Ont., estimated to cost about $300,000.

Mid-Continent Tire Plant in Wichita—The Mid-Continent Tire Mfg. Co. has purchased a site at Thirteenth and Washington Streets, Wichita, Kan., upon which to erect its factory building. The building and equipment will cost $150,000.

To Make Accessories—The C. D. Mfg. Co., Marietta, Ohio, will be incorporated with $100,000 capital by F. A. Caskey and others to manufacture automobile accessories. Temporary factory operations will be carried on in the plant of the Galvin Mfg. Co.

Juno Truck Plant Sold—The former plant of the Juno Motor Truck Co., Juneau, Wis., which has been idle for more than a year, has been turned into a milk condensery. The company was organized about four years ago to take over the business of the Brodesser Motor Truck Co., Milwaukee, but after an existence of about two and a half years retired from business.

Ohio Plant News—The plant of the Elmore Automobile Co., Clyde, has been sold to the Universal Paper Products Co., of Chicago. The deal means the passing of the plant, which was one of the most important in Northern Ohio several years ago.

The plant of the Toledo-Findlay Tire Co., Findlay, which went into the hands of receivers several weeks ago and which has been idle since that time, has been placed in operation by Sheriff Kennedy, who has been placed in charge. A movement is on foot for a reorganization of the concern by the stockholders.

The McIntyre Mfg. Co., Columbus, has started ship motor plows from its plant. The first shipment was made to a point in Nebraska. The output of the company is being gradually increased.

The Automobile Calendar

April 24-29.....Bangor, Me., Show.
April 26-May 6...Oakland, Cal., First Annual Pacific Coast Motor Power and Automobile Show, Automobile Industries Assn.
April 29.....Fresno, Cal., Road Race, Raisin Classic Trophy Assn.
May 3.....N.A.C.C. Monthly Meeting.
May 6.....Sioux City, Iowa, Speedway Race, Sioux City Speedway Assn.
May 9-12.....Hot Springs, Va., N. A. A. A. J. Meeting.
May 13.....New York City, Sheepshead Bay Speedway Race. Metropolitan Trophy, 150 miles; Queens Cup, 50 miles; Coney Island Cup, 20 miles, and Brooklyn handicap for non-winners, 10 miles.
May 13-14.....Columbus, Ohio, Track Race, Columbus Driving Park. Cee - Cee - Dee League.
May 14-20.....Milwaukee, Wis., Sheridan Road Week to Complete Highway Connecting Milwaukee and Chicago.
May 18.....S.A.E. New York Section, May Meeting.
May 20.....Chicago Non-Professional Speedway Race, Western Interclub Speedway Park.
May 25.....Pennsylvania's Second Good Roads Day.
May 26-27.....Del Monte, Cal., Meeting, Three Divisions of National Assn. of Automobile Accessory Jobbers.
May 28-30.....Cleveland, Ohio, Track Race, Cee - Cee - Dee League.
May 30.....Des Moines, Iowa, Iowa Derby, 20 Miles; Des Moines Special, 10 miles.
May 30.....Tacoma, Wash., 10, 20 and 30-Mile Races, Tacoma Speedway Assn.
May 30.....Elmira, N. Y., Track Race, Elmira Auto & Motorcycle Racing Assn.
May 30.....Indianapolis Speedway 300-Mile Race.
May 30.....Minneapolis, Minn., Speedway Race.
June 4.....Sheepshead Bay Speedway, 30-Mile Race, American Liberty Day Committee.
June 8.....New York City, Orphans' Day Outing at Donnelly's Grove, College Point, L. I. Orphan's Automobile Day Outing Assn.
June 10.....Chicago Speedway Race. International 300 - Mile Race, Speedway Park, Speedway Park Assn.
June 12-16.....S. A. E. Summer Trip on Great Lakes.
June 16-17.....Sheepshead Bay Speedway, 24-Hr. Race, Trade Racing Assn., New York City.
June 20.....Galesburg, Ill., Track Race, 100 miles.
June 28.....Des Moines, Iowa, Speedway Free-for-all, 300-mile race.
July.....LaGrande, Ore., Track Race, LaGrande Motor Club.
July 2-6.....Detroit, Mich., World's Salesmanship Congress, Detroit Board of Commerce Bldg.
July 4.....Coeur d'Alene, Idaho, Race Meet, Hiller-Riegel Co.
July 4.....Tacoma, Wash., Speedway Race, Tacoma Speedway Assn.
July 4.....Minneapolis 300-Mile Speedway Race.
July 4.....Sioux City Speedway Race.
July 15.....Omaha, Neb., Speedway Race.
July 15.....North Yakima, Wash., Track Race, Riegel-Hiller Co.
July 17-21.....Dallas, Tex., Tractor Demonstration.
July 24-28.....Hutchinson, Kan., Tractor Demonstration.
July 31-Aug. 4....St. Louis, Mo., Tractor Demonstration.
Aug. 5.....Tacoma Speedway Race, Tacoma Speedway Assn.
Aug. 7-11.....Fremont, Neb., Tractor Demonstration.
Aug. 11-12.....Pikes Peak, Col., Hill Climb, Pikes Peak Auto Highway Co.
Aug. 12.....Portland, Ore., Track Race, Riegel-Hiller Co.
Aug. 14-18.....Cedar Rapids, Ia., Tractor Demonstration.
Aug. 18-19.....Elgin Road Race, Chicago Auto Club.
Aug. 21-25.....Bloomington, Ill., Tractor Demonstration.
Aug. 28-Sept. 1...Indiana Tractor Demonstration.
Sept. 2-9.....Columbus, Ohio, Fall Show, Ohio State Fair, Columbus Automobile Show Co.
Sept. 4.....Des Moines Speedway Invitation Race. Limited to six entries.
Sept. 4.....Indianapolis Speedway Race.
Sept. 4-5.....Spokane, Wash., Track Race, Inland Auto Assn.
Sept. 4-8.....Madison, Wis., Tractor Demonstration.
Sept. 6-7.....St. Paul, Minn., Good Roads Congress, Auditorium.
Sept. 11-16.....Milwaukee, Wis., Fall Show, Wisconsin State Fair, Milwaukee Automobile Dealers.
Sept. 16.....Providence Speedway Race.
Sept. 29.....Trenton, N. J., Inter-State Fair. H. P. Murphy, Racing Sec.
Sept. 30.....New York City, Sheepshead Bay Speedway Race.
Oct. 7.....Philadelphia Speedway Race.
Oct. 7.....Omaha Speedway Race.
Oct. 14.....Chicago Speedway Race.
Oct. 19.....Indianapolis, Ind., Race, Indianapolis Motor Speedway.
Nov.....Santa Monica, Cal., Vanderbilt Cup and Grand Prix Races.

The Week in the Industry

Ohio Trade Happenings—The Vim Motor Sales Co., which has been formed in Columbus to distribute Vim trucks, has established its showrooms and service station in the New Columbus Auto Repair Co. Building at 103 South Front Street.

The Times Square Automobile Co. of New York and Chicago, which has purchased the bankrupt stock of automobile accessories of the Columbus Automobile Supply Co., at Gay and Fourth Streets, Columbus, will open a permanent branch store of this company, under the management of S. E. Brown and W. H. Montague, at 137 South High Street.

Twin City News—The Auto Engine Co., University Avenue and Griggs Street, St. Paul, will take over the space in its plant occupied by the Dussenberg Motor Co. The latter has moved to the Lowe-Victor Building, Chicago. The extra space was needed for increased business.

The Morton Brake Co., 45 Tenth Street S., Minneapolis, has begun the manufacture of the Morton Four-Wheel brake, whose power is applied by foot pedal pressure. The mechanism is simple and saves wear on tires by its use by elimination of tire chains.

Wis. Trade Items—The National Weighing Apparatus Co., 917 Third Street, Milwaukee, has taken new and larger quarters, consisting of the former plant of the Milwaukee Separator Co., at 267-273 Sixth Street. The capacity is thereby doubled. The officers of the company are: President, John Malenscheck; vice-president, John Dobnik; secretary and treasurer, J. L. Malenscheck.

The I. B. Rowell Mfg. Co., Waukesha, which has devoted its attention for many years to the manufacture of farm implements, has taken several large contracts to manufacture automobile devices for patentees who do not desire to establish works of their own. One order is for 60,000 self-starting devices for Ford cars, to sell at $30 each, and another order is for a large production of road surfacers and other light road machinery. Extra help has been engaged and the facilities extended to fill the orders.

The Roebken Garage at Cedarburg has been purchased by the newly organized Boerner Automobile Co., which takes immediate possession. The Boerner company proposed to build a new garage, but the project is indefinitely postponed because of the purchase.

Trade Happenings

Willson Heads Brooklyn Chevrolet—J. H. Willson has been made manager of the Brooklyn Chevrolet branch. Willson comes from the New York City branch.

Krueger Owns Milwaukee Cole Branch—W. H. Krueger, who recently went to Milwaukee to assume charge of the Cole company's distributing branch in that city, has purchased outright the Milwaukee business, and is not connected with the Cole Motor Co. of Chicago, as reported.

Detroit Changes—H. F. Hartman, who has been identified with the service activities of the Studebaker Corp. for the past five years, has just been appointed superintendent of the Detroit Studebaker service station. Previous to his present appointment Mr. Hartman was in charge of service at the Philadelphia branch, and before that supervisor of service for the States of Texas and New Mexico.

L. S. Weeks, formerly factory representative of the Studebaker Corp., has been appointed manager of the Atlanta, Ga., branch, and J. B. Dub, formerly salesman for the Detroit retail branch, has been made manager of the retail department at Atlanta.

Cyril O. Assmus has been appointed export representative in Detroit of the Maxwell Motor Co., succeeding A. S. Stevens, export manager of the company, who will hereafter have his headquarters in New York, and who will shortly leave there for South America.

Goodyear Trade Notes—R. W. Rost, Newark, N. J., salesman, has been promoted to manager of the Goodyear branch at Albany, N. Y., succeeding E. B. Sigerson, recently appointed manager of the Buffalo branch.

J. A. Leathermen, Portland, Ore., salesman, has been promoted to manager of the branch in that city.

L. H. Vaughan, former manager at Utica, N. Y., has been appointed manager of Goodyear's branch at Newark, N. J. He is succeeded at Utica by F. G. Richards, who has been connected with the Newark branch as salesman.

R. S. Herman, formerly a salesman with the Joplin, Mo., branch, has been transferred to Salina, Kan., as manager of the new Goodyear branch there.

Knepper a Factory Rep.—H. H. Knepper has withdrawn from the Knepper-Knight Co., Detroit, and has opened an office at 967 Woodward Avenue, that city, where he will continue to handle the account of the Marshall Ventilated Mattress Co., maker of the Marshall springs for automobile backs and cushions; the Polson Mfg. Co., auxiliary seats, and windshields, and the Lipman Air Appliance Co., maker of air, water and oil pumps. He is also handling the account of the M. J. Whittall Associates, makers of automobile carpets.

The name of the Knepper-Knight Co. has been changed to the Knight Co., the latter company having taken over all the interests that H. H. Knepper had in the former company. The company has the distribution of Soss hinges, Eaco horns, Inland piston rings and Boston gasoline gages.

Cowie Electric in Wichita—The E. S. Cowie Electrical Co., Kansas City, Mo., maker of electrical motor appliances, has acquired a lease on a building in Wichita, Kan., and will establish a branch house there before June 1.

Canadian Trade Items—The Dominion Automobile Co., handling the Hudson and Peerless cars, is installed in its bright and commodious new quarters at 146, 150 Bay Street, Toronto, Ont. A complete service department with a full compliment of parts has been installed.

S. Trusler, Hupp agent for the counties of Essex and Lambton, has formed a new company to be known as the Trusler-Carrick Co. This company has rented a fine showroom at 63 Ouellette Avenue, Windsor, besides show rooms and garage at Sarnia. In addition to the Hupp, the full line of the Gray-Dort Co. will be handled. Mr. Trusler will manage the Windsor business and Mr. Carrick will look after the business in Sarnia.

Northwest News—The Mitchell Motor & Service Co., Seattle, will shortly begin the construction of a new home at East Pine and Summit Avenue. The new Mitchell Building will provide 12,000 sq. ft. of floor space.

Hugh Chalmers, president of the Chalmers Motor Co., spent the past week in Seattle as the guest of J. C. Garner, local Chalmers representative. He was also the guest of the Seattle Ad Club, to whom he gave an intensely interesting and instructive address, which was heard by more than 300 prominent Seattle business men.

G. N. Bussell and A. Goodrick, proprietors of the Glendale Auto Brokerage Co., Tacoma, have taken the Western Washington distribution for the Trailmobile.